

Fol. 41 ASS

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ICES CM 1995/Assess:13

PART 1

REPORT OF THE HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

ICES Headquarters, Copenhagen, Denmark

27 March - 5 April 1995

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3106/G 3871

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1. INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The working group met at ICES Headquarters from 27 March - 5 April 1995 with the following terms of reference (C.Res. 1994/2:6:4):

- assess the status of and provide catch options (by fleet where possible) for 1996 and 1997 for the North Sea autumn-spawning herring stock in Division IIIa, Sub-area IV, and Division VIId (separately, if possible, for Divisions IVc and VIId), the herring stocks in Division VIa and Sub-area VII, and the stock of spring-spawning herring in Division IIIa and Sub-division 22-24 (Western Baltic);
- assess the status of the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;
- provide the data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1994 by statistical rectangle of the North Sea for herring and sprat);
- for those stocks and/or fisheries where data permit, provide the information required to give advice or guidance on i) medium-term management objectives (in terms of spawning stock biomass and mortality rates) and options; ii) the appropriateness of controls on catch (or landings) and fishing effort; iii) the potential for multispecies and multi-annual catch options;
- analyse the herring and sprat data from the quarterly International Bottom Trawl Surveys in

the North Sea and Division IIIa and evaluate the potential usefulness of the surveys in assessments;

- incorporate new information from the Working Group on Pathology and Diseases of Marine Organisms to assess the impact of *Ichthyophonus* on herring.

1.3 Report of the Planning Group for Herring Surveys

A report was represented of the meeting of the Planning Group for Herring Surveys (Anon. 1994a). This group had considered a number of technical problems concerning the analysis of herring acoustic surveys. Particular attention was given to methods for species allocation of acoustic records, and to procedures for combining disaggregated length and age data from individual trawl stations. An estimate was made of the precision of the abundance estimate of each age class by removing individual hauls from a particular set of survey data for Division IVa, and considering the effect of this on the estimated age composition. It was found that abundance estimates for 1- and 2-ringers were rather variable, but that estimates for older groups were less sensitive to the removal of individual hauls.

The Planning Group considered the feasibility of synchronising the herring acoustic surveys in Division IIIa with those in the western Baltic. The Division IIIa survey is now conducted in July at the same time as the international survey in the North Sea. The advantage of this timing is that Baltic spring spawners are correctly counted, irrespective of whether they are still in the North Sea or in Division IIIa. Postponing the survey until October (in order to synchronise it with the western Baltic survey) would create difficulties in estimating the Baltic spring spawners. These herring are then distributed in shallow waters of the Öresund, and cannot be readily assessed by acoustic methods. Changing the timing of the western Baltic survey would also present problems. The survey is conducted in October because the sprat and 1-ringed herring are distributed in the open Baltic at that time. In July the sprat and juvenile herring are still distributed in shallow waters where then cannot be measured by acoustic means. In view of these problems, it was concluded that there was no gain in aligning the timing of the two surveys.

The contagious distribution of herring in Division VIa was identified as the cause of the high variance on the survey estimates for that area, resulting in widely different estimates in 1992 and 1993. To reduce this problem, the Planning Group suggested a change in survey strategy, and a concentration of effort in known areas of aggregation. This has since been implemented.

Concerning the planning of future surveys, the Planning Group drew attention to the need for better estimates of 1-ringed herring and sprat. These fish are mainly distributed in the central and eastern parts of Division IVb, and in the inshore areas of the Moray Firth and Firth of Forth. Coverage of these areas would require a considerable amount of additional survey effort, particularly in the eastern central North Sea.

The Planning Group prepared the first version of a Manual for Herring Acoustic Surveys in ICES Division IIIa, and Sub-areas IV and VI. This manual should contribute towards standardisation of methods between countries and areas.

1.4 The effects of *Ichthyophonus*.

1.4.1 Results of sampling

There was a substantial review and evaluation of all the data available on *Ichthyophonus* infection rates in the report of the Working Group for 1994 (Anon. 1994). This showed that the prevalence of the disease has been declining since 1991. The data collected during 1994, and reported to this Working Group, again show low levels of the disease in the North Sea and in the Skagerrak and Kattegat, although one report from Sweden noted some evidence of an increase in the level of infection in the younger year classes in the Kattegat.

The overall level of sampling for *Ichthyophonus* declined in 1994. Some countries now feel that the infection rate has fallen to such a low level that the monitoring effort can no longer be justified by the results. The only data on the rate of infection by length or age groups for the North Sea were recorded during acoustic surveys in July / August by Norway and the Netherlands and also from the Norwegian commercial fishery. Norway also provided age-related data from research vessel surveys in the Skagerrak. Sweden and Iceland provided data on infection rates by length groups from research vessel surveys. The only sampling of commercial catches was carried out by UK (Scotland), Norway and Sweden.

Tables 1.4.1a and 1.4.1b give the total number of fish examined, from research and commercial vessel catches, by each country, by division, for the North Sea. Infected fish were only found in the northern North Sea with the highest incidence from the Norwegian research vessel surveys in June / July; 19/1363 and October / November; 11/856.

Table 1.4.2 a shows the results of sampling by Sweden in the Skagerrak, Kattegat and The Sound. Their extensive sampling from research vessel surveys and commercial catches, spread evenly across the four quarters of the year, indicates a very low level of infection in these areas. The quarterly data did not

show any seasonal trends. Details of some additional sampling by length groups (Table 1.4.2 b) by Sweden off their west coast (Kattegat) show that the prevalence of the disease in that area is low. The data also show a higher level of infection in research as opposed to commercial catches from the same area. A small number of samples was taken by Norway in the Norwegian Skagerrak in February 1994 (Table 1.4.3). They show a high prevalence in the 3 winter ring group. None of the 1 or 2 ringers examined (numbers not reported) were infected. It should be noted that the number examined was very low.

The results of sampling by UK (England) in the Irish Sea, and by Iceland in their waters, is presented in Table 1.4.4. The level of infection in Icelandic waters was very low. No infection was detected in the small number of samples from the Irish Sea.

In addition to the data listed in the tables, Germany and Estonia also provided some information. Germany has ceased systematic sampling in the Baltic and in the northern North Sea, but did make some observations during a stock assessment survey in the northern North Sea in February 1995. They reported that the disease was still present in the area and that to the south-west of the Norwegian coast "a considerable number" of infected herring were found among the larger size groups, particularly in areas where herring catches were small. On a transect from the western Baltic to the Gulf of Finland, "hundreds" of fish were examined but none were found to be infected. During research vessel surveys in Estonian waters in 1994 no infection was detected in 960 herring and 310 sprats examined. This compares with infection rates of 0.2% for herring and sprat in 1992/1993 and 3% for herring and 1.5% for sprat in 1991.

The draft report of the ICES-coordinated acoustic surveys of the North Sea was made available to the Working Group. Samples from all the catches of herring were examined for the presence of *Ichthyophonus*. A total of 28 infected fish were recorded from 7 of the 46 rectangles where herring were found. The number of infected fish was raised by the acoustic estimate of total numbers of herring in the area. This gave an estimate of 45 million fish infected in Division IVa which was 0.25% of the total population surveyed or 0.8% of the herring found in Division IVa. The numbers of fish infected in Division IVa was insufficient to obtain an age breakdown

The report concludes that the results of the acoustic survey observations do not indicate any substantial spread of infection to younger fish. To some extent they confirm that the infection is now in even older fish than previous years although the low numbers make any conclusion from the age data unreliable. The decreasing prevalence, 5% in 1992, 3.6% in 1993 and

0.8% in 1994, suggests that the influence of the disease on the population is declining substantially.

A working document was presented by Skagen (WD 1995) which summarizes four years (1991-1994) of Norwegian data from two annual research vessel surveys (Table 1.4.5) and presents data from the commercial fishery in Division IVa in 1994 (Table 1.4.6). The data show a general decline in disease prevalence in the northern North Sea. The report concludes that the summer data in particular are compatible with the hypothesis that the fungus infects parts of a year class at a fairly early stage in the life history, and induces an additional mortality to the infected part over a long period of time. The conclusion does not exclude other explanations for the trends in the disease prevalence. A morphological correlate to the proposed incubation stage is not known at present. The present findings indicate, however, that systematic investigations of the early stages of the disease may be a useful direction for further studies.

1.4.2 Possible influence of *Ichthyophonus*-induced mortality on stock assessment

The working document by Skagen (WD 1995) presented evidence that an additional mortality of about 0.5 on the 1985, 1986 and 1987 cohorts could well explain the observations of infected fish made in the Norwegian summer surveys. Although this pattern was not observed in the autumn surveys or in the international acoustic surveys, it was decided to test the effect of including such additional mortality in the assessment. For test purposes a population model was fitted as described by Patterson (WD, 1995) using updated information. The fit was then repeated with the M on the 1985 - 1987 cohorts, after 1991, incremented by 0.5. The two fits were not statistically distinguishable (Variance - ratio $F = 1.044$ for 172 d.f.; $P(F) = 39\%$), and there was only 14% difference in the estimate of spawning stock size. It is clearly difficult to assess the effect of additional mortality along one or more cohorts as this parameter will be confounded with the estimates of cohort strength. This simple trial failed to provide evidence that the additional mortality should be included for stock assessment purposes.

1.4.3 General conclusions

Low levels of the disease still persist in many areas but it is not known whether these represent background levels as opposed to epidemic proportions. There is a general perception, both from research vessel data and from the commercial fishery, of a significant decrease in the prevalence of *Ichthyophonus* in the North Sea and Division IIIa in 1994. There is no evidence that the disease at present induces any appreciable additional mortality on the North Sea herring stock or on the Western Baltic herring in any area. The Working

Group views with concern the decrease in sampling intensity for this disease. The dynamics of the disease are far from understood, and there remains a very strong possibility that outbreaks of this parasite are an important factor in the ecology of the herring. As sampling should not be abandoned merely because the prevalence of the disease is low at present.

1.5 Evaluation of the quarterly IBTS.

Available data consist of preliminary indices from 1991 to the first quarter in 1995 based on catch of fish below a defined length class. The short time series of quarterly surveys precludes a statistical evaluation at present. The Working Group therefore decided to look for changes in relative abundance or in distribution in order to attempt a qualitative evaluation.

The mean catches by quarter of a year class progressing through the surveys are shown for herring in Figure 1.5.1 and for sprat in Figure 8.8.1. In the case of herring, a cohort first appear as 0-ringers in the second quarter, gradually increasing in abundance to reach a maximum in the third or the fourth quarter the following year as 1-ringers. In the case of sprat a cohort first appears in the second quarter in low numbers and maximum abundance occurs in the fourth quarter the following year as 1-ringers. Total mortality, based on the mean abundance in the same quarter in year N to year N+1, is shown for herring in Table 1.5.1 and for sprat in Table 1.5.2. The negative values indicate variable catchability between quarters for both species. However, they are more pronounced for sprat than herring, indicating a strong influence of behaviour or mesh selection in the gear on the indices for sprat.

If the variation in abundance in the survey data is significantly influenced by catchability then the true distribution cannot be described. The Working Group did not have time to analyse this further during the meeting.

The recruitment indices used to predict the strength of the incoming year classes for herring in the North Sea are based on a long time series of first quarter survey data. These series have been tested thoroughly and show a good relationship with the year class strength estimated from the converged part of the VPA. The good relationship suggests that any factors influencing catchability have been consistent in the first quarter. In addition the MIK estimate gives a relatively good prediction of the year class strength as 0-ringers.

For sprat, it appears at present that the fourth quarter data may produce a usable 1-ringer index. Availability of a fourth quarter index would be valuable to have an index that fulfils the criteria as an early predictor of year class strength, a MIK index based on sampling in the fourth quarter, should be considered.

1.6 Assessment Methods

The methods available to the Working Group were XSA and Laurec-Shepherd VPA-tuning methods, and the Integrated Catch Analysis (ICA) method that was reviewed extensively at the previous meeting of the Working Group (Anon 1994a). In 1994 the Working Group adopted the ICA method for the assessment of herring in Division VIa(N) the Celtic Sea and in Division IIIa and the Western Baltic. This year that method has also been adopted for the assessment of North Sea herring, and its use retained for the other stocks. The reasons for this are:

- Problems of inconsistency in the data have now been resolved (see Section 2.7.1.).
- An assessment of North Sea Herring calculated using XSA and following the Advice to Working Groups from ACFM and the Secretariat in 1993 produced a stock size estimate of 2.2 million t in 1992. A comparative assessment using the Adapt method produced an estimate of SSB of 1.06 million t. The present perception of stock size in 1992 is below 900,000 t.
- The XSA method was designed for large data sets typical of North Sea demersal assessments. It can be numerically unstable when applied to small or very noisy data sets. For example, in the assessment of sardine in Divisions VIIIc and IXa, the estimate of F at the oldest age was found to depend principally on the number of iterations made by the program, as below:

Iterations:	30	60	120	240	500
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F on age 5:	1.30	1.63	2.22	3.18	4.48
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(Source: Anon. 1995)

The XSA implementation available to the Working Group does not provide an indication to the user that the algorithm is not converging. Similarly, in the assessment of herring in Division IIIa and the Western Baltic, it was found that arbitrary choices about shrinkage could change perceptions of stock size from 433 000t to 1 835 000t (Anon., 1993a). The ICA allows fixed weights to be specified, so avoiding the sort of numerical instability that can arise from inverse-variance reweighting with few data. In addition, if a shrinkage option is chosen this calculation is completed outside any iterative scheme that might be unstable.

- With the smaller data sets used in pelagic assessments and with the faster computers now installed at ICES, the faster computational algorithm used in XSA was not required.

- The ICA allows estimation of a variance-covariance matrix for the estimates of population size, selection pattern and annual fishing mortality, and also allows estimation of stock-recruitment relationship parameters. This affords improved estimates of uncertainty in the stock assessment and in the projections.

For its purposes the Working Group considers the use of well-defined statistical methods such as ICA to be preferable to methods like XSA that are based on somewhat *ad hoc* rules that have been defined from long experience of the assessment of demersal stocks. However, the least-squares model implemented in ICA is not necessarily the best of the statistical methods that have been developed to date. Other methods such as ADAPT, maximum-likelihood 'stock-synthesis' methods, time-series methods and parameter-sparse models have not, to the Working Group's knowledge, undergone comparative testing in the pelagic fisheries context. Such testing would be helpful for the Working Group.

1.7 Medium-Term Projections

A medium-term projection needs to include the following elements:

- An estimate of the parameters of the initial stock structure, e.g. the age composition and the associated variances.
- A model of the recruitment process (with or without account of environmental factors)
- A model of the natural mortality process
- A model of growth in the population
- A scenario of the exploitation strategy

The importance of these various elements in the projections varies according to the definitions of "medium term". Their importance also depends on the total mortality level on the stock which for many commercial fish stocks is dominated by the exploitation level. The definition of 'medium term' is discussed, and various components of projection models are reviewed briefly. A preliminary attempt is made at specifying a requirement for a projection model, and for illustrative purposes some projection calculations are made using a projection model of that type.

Natural mortality and growth (as increase in weight with age) were not considered to be a dominant part of the problem and are not considered further here.

1.7.1 Definition of "MEDIUM TERM"

The Group realized that the length of the time period "Medium Term" was not well specified and discussed an appropriate definition. There is no need for a very precise definition of "medium term" but different

definitions may lead to grossly different time spans being included in the projections. Different point of views were presented.

The medium term is the period:

- 1) in which the year classes which have been estimated in the stock at the time of departure of the projection still **represent a major part** of the catch (total biomass or SSB). A major proportion could e.g., be 50 %. In the case of herring this would be some 3-4 years.
- 2) in which the year classes which are estimated in the stock still **have an appreciable effect** on the catch (or stock (wt or numbers) or SSB). In the case of herring this may be 6-10 years.
- 3) the choice of which is not based on biological considerations but **defined outside**, e.g., the planning horizon (5-10 years) for a fishing fleet.
- 4) of years for which the projection is **informative**. For example, a projection into the future is no longer "Informative" if the uncertainty about the prediction becomes so large that, in effect, no prediction can be made. Under some scenarios projections may tend towards an equilibrium situation, after which further extensions of the projections in time add no further information to perceptions of the likely future development of the stock.

In cases 1) and 2) it is important to have a reliable estimate of the present population size and structure while the recruitment process is crucial when using definition 3).

Definition 1

This definition concentrates on the progression of the year classes already present in the stock at the time when initiating the prognosis. The definition varies somewhat with the ratio between the recruitment and the initial state of the stock. Under constant recruitment the presence of a strong year class in the initial age composition will make the medium term longer than if the initial state is a depleted stock. However, even though this definition may not be very exact, an appropriate averaging of year class strength and initial state will suffice as a basis for the definition.

This definition represents the time scale in which it will be possible to make fairly precise projections. The definition suggests that medium term is approximately one generation.

Definition 2

This definition depends on the recruitment model, in particular whether a stock-recruitment (S-R)

relationship exists or not. If there is no S-R relationship then this definition reduces to Definition 1. However, under a S-R relationship the consequences of the initial state of the stock may be seen for a long time in the population. This is due to the time it may take for a stock to recover from a depleted state: one or several strong year classes should appear, contribute to the SSB and their progeny also contribute to the SSB and the oscillations damp out.

This definition may be relevant to demonstrate the period in which consequences of management will affect the stock. "Medium term" under this definition may well include several generations.

Definition 3

This definition concentrates on the use to be made of medium-term projections and as such may be more relevant for the customers (the fishing industry or the managers of fisheries) than the population dynamic definitions proposed above. The quality of any projections based on such a definition will vary greatly between stocks depending on the initial state and the recruitment process.

Definition 4

This definition concentrates on the practical uses to which a projection is put. It is expected that the purpose of the projections will be to indicate the likely future development of the stock under a range of different scenarios. It is proposed that such projections should not be calculated further than the time horizon within which some reasonable predictions can be made. In practice, this time horizon will depend on the particular assumptions about recruitment and exploitation included in the scenario. For example, a projection based on random recruitment and low, constant fishing mortality will eventually tend to a steady state after a rather extended number of years. Conversely, a projection based on high and constant catches will tend to be dominated by uncertainty after a very short period. The working group proposed to accept this Definition 4 as a working definition of 'medium term' for practical reasons.

1.7.2 Estimating uncertainty in present population parameters

The accuracy of stock estimates depends on the accuracy of the data on which these estimates are based and the accuracy of the stock predictions depends very much on the accuracy with which recruitment can be estimated. The data required for stock assessment are usually a historical catch-at-age matrix together with some survey data while the recruitment levels are usually based on some sort of survey data. In order to provide some measure of precision or confidence about future stock sizes some method must be available

which can measure variance in the catch-at-age data and in the survey data.

At present there does not seem to be any apparent method of estimating variances that may occur in the age distribution of catches which may arise from inaccurate age determinations. Various workshops have addressed the problem of differences arising from different interpretations but so far statistical treatment of catch-at-age data has not been developed. Survey data - e.g. estimation of variances occurring between indices derived from different hauls and confidence limits around total egg production - may lend themselves more readily to more precise statistical evaluation. However, it does not yet appear possible to measure the variance that surrounds stock estimates and to carry these into the stock predictions either on a short-term or a medium-term basis, as the variances of the input data are not estimated.

Fournier and Archibald (1982) state that "it is simply an inescapable fact that the age structure and effort data do not contain enough information to determine the relative accuracy of the ageing data, the total catch data, the regularity of fishing mortality or the closeness of the relationship between effort and average fishing mortality."

If the variances of the catch and survey data are known or can be assumed, a method for estimating the uncertainty in the stock assessment was available to the Working Group in the ICA program (Patterson and Melvin, WD 1995; Patterson, WD 1995), which allows the estimation of the variance-covariance matrix for the following parameters:

- Population sizes in the last year of the catch-at-age observations
- Fishing mortality on reference age
- Selection at age
- Parameters of the Beverton and Holt stock-recruit relationship.

As noted above, there are no external estimators of variances of the surveys available, or of the catches at age. The only available means of assessing the variance of the parameter estimates was by either using iterative reweighting schemes (which with the small data sets available for pelagic stocks are likely to be numerically unstable and overparameterized), or assigning arbitrary values to the variances on the input data. Neither method is considered satisfactory, and the Working Group stresses the need for independent estimates of the variances. However, in the absence of such variance estimates, the Working Group considered it feasible to calculate projections based on the parameter covariance matrix that is calculated using the same prior assumptions about input variances that are made in the usual stock assessment procedure.

1.7.3 Estimating future recruitment and uncertainty in future recruitment

Although the estimation of the uncertainty in present stock size and mortality parameters is problematic, the construction of a meaningful simulation model for future recruitment, that is a simulation model which can mimic the observed historical recruitment patterns, is the more difficult problem.

A number of possible models for North Sea herring recruitment were discussed. The central problem is that runs of high and low recruitments have occurred. One such period of low recruitment coincided with periods of high fishing mortality and subsequently a stock collapse occurred. As the periods of high fishing mortality, low stock size and low recruitment coincide it is not entirely clear what causal relationship is involved, ie whether a run of low recruitments preceded or was caused by a period of low spawning biomass. Such runs of low recruitment substantially increase the risk of stock declines when fishing activity is at a rather constant level. Perceptions of serial correlations in recruitment are therefore extremely important for the estimation of risk in projection scenarios.

On account of these perceptions of strong serial correlations in recruitment, it was considered unrealistic to model future recruitments as having a random, uncorrelated error structure. Such an assumption would underestimate the risk of a stock decline, as under a simple error model one would expect a low recruitment to be compensated for by a high recruitment one or two years later. Under assumptions of serial correlations in recruitment, a low recruitment is more likely to be followed by further low recruitment.

Despite the apparently strong influence of environmental variation on recruitment, it was considered to be unrealistic and incautious to assume that future recruitments would be independent of stock size. Although serious reservations were expressed about both parameter estimation and the appropriateness of the functional form, it was concluded that using a Beverton and Holt function would at least avoid the assumption that recruitment is independent of stock size.

A population model was fitted to the available information and a Beverton-Holt stock-recruit relationship included in the fit. In a simple attempt at describing the structure of the data a time-series model was fitted to the residuals about the stock-recruit relationship. The relationship fitted to the residuals was :

$$R_y = a. R_{y-1} + b. R_{y-2} + c. R_{y-3} + d. R_{y-4} + \epsilon_y$$

where R_y is $\ln(\text{Observed Recruits}) - \ln(\text{Predicted Recruits})$ in year y , and ϵ is a normally-distributed error. The model was fitted using a nonlinear minimisation of the sum of squared ϵ .

The estimates of the parameters obtained were:

a: 0.5824
b: 0.2152
c: -0.04
d: -0.1564
variance of ϵ : 0.2346

It was concluded that an appropriate model for estimating future recruitments would be to assume that recruitment depends on stock size according to the fitted Beverton and Holt stock-recruit relationship, but in the stochastic simulations the predicted recruitment should be perturbed with a rather strongly serially-correlated error. Some time-series of simulated errors about the stock-recruit relationship generated using the parameters estimated above are given in Figure 1.7.1, together with an uncorrelated time-series for comparison.

1.7.4 Management constraints

When projecting in the "medium term" it may be assumed that management actions will influence the stock development and the fishing possibilities. A model for calculating such medium-term projections should therefore be capable of modelling the effect of management action on the stock. A useful model for projections should therefore include options for creating scenarios allowing a comparison of the possible effects of different management actions. The following section discusses how such scenarios may be constructed.

Management objectives have rarely been formulated precisely but proposals include elements like restricting the fishing mortality or maintaining the SSB above some prespecified level (MBAL). The fisheries dealt with by this Working Group are regulated either by TACs (e.g., herring fisheries for human consumption in the North Sea) or by by-catch restrictions in the industrial fisheries in the North Sea. There are also mesh size regulations.

Short-term projections are at present (for the North Sea and Division IIIa) calculated on a fleet-disaggregated basis. A fleet may exploit several stocks occurring in the same area. The Working Group requires a method which would be able to deal with a regulatory system where a fleet may be either restricted by a TAC, effort constraint or a by-catch constraint.

The number of possible scenarios are infinite. It was recognised that the users of the advice should actually be responsible for presenting the scientists with those scenarios which may be useful for management. This has not been done at present and therefore the Group as an illustration of what may be possible defined three scenarios and simulated the "medium-term" projections.

1.7.5 Multispecies considerations in Medium-Term analysis

Although it is likely that the multispecies effects may be more pronounced in the demersal stocks than in pelagic stocks, it was recognised that it is probably unrealistic to base medium-term projections on single-species considerations alone (see Gislason (1993) and the simulations made by various working groups over the years). Multispecies "medium-term" projections would be required if only to check whether the available models indicate strong multispecies interactions or no multispecies effects on the stocks under discussion. The Herring Assessment Working Group will at its next meeting have such simulations available for a continuation of this discussion. At that time it is also expected that the Multispecies Working Group will have finalized its current ongoing review of the database.

1.7.6 Availability of computer programs for Medium-Term projections

Due to the short time available to the Working Group to initiate risk analyses on medium-term projections it was decided to examine what methods were available to undertake medium-term calculations.

The methods reviewed by the Working Group were :

1. The multi-species forecast program, MSFOR.
2. Extensions of the ICA program
3. Programs and routines inside EXCEL
4. Methods used by the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

1. The multi-species forecast program, "MSFOR", incorporates a risk analysis for medium-term projections (Gislason, 1991 and 1993). As such, this may be a good option for undertaking this task. Another advantage with the multi-species model is that it incorporates other stocks, so that a more complex analysis could be undertaken which allows, for example, an ecosystem level approach to be taken. However, for the time being there are some problems with the data for the multi-species assessments, so the program is essentially unavailable. The other restriction for using the multi-species model is that at

present it is only available for the North Sea and the Baltic. However, this program only models uncertainty in future recruitments as an uncorrelated random variate. Uncertainty in present population parameters is not yet included in the model.

2. Extensions of the ICA program. A suite of programs that utilize the finishing population estimates and variance-covariance matrix generated by ICA was presented to the Working Group. Variances in projected populations can be computed in one of two ways (delta method or parametric bootstrapping (Monte-Carlo simulation)). The main differences between the two methods are that the delta method assumes that the variance and covariances can be combined linearly for the projections whereas the Monte-Carlo method does not make this assumption. However, it does ignore the covariances. Both methods assume that the errors about the assessment are lognormally distributed and that there is no process error. Details of these two methods are given by Patterson (1995 WD). There are also two constraints which can be applied independently by year for up to six fleets as either a specified F-multiplier relative to the last year of the assessment or as specified catches by year and fleet. There are therefore four possible combinations for analysis:

- a. F constraint using the delta method
- b. F constraint using the Monte-Carlo method
- c. Catch constraint using the delta method
- d. Catch constraint using the Monte-Carlo method.

One major advantage of these programs is that they utilize the output from the ICA program directly, thus maintaining statistical consistency between the assessment and the projection. Two disadvantages were noted, however.

Firstly, the programs can apply fleet-disaggregated catch constraints or fleet-disaggregated F constraints in the projections, but it is not possible to include mixed constraints, *ie* catch constraints on some fleets and F constraints on others. This matter should be addressed.

Secondly, the programs assume a random, uncorrelated error in recruitment about the fitted Beverton and Holt stock-recruit relationship, which was considered unrealistic. This was rectified at the meeting and the recruitment model was altered to include an autocorrelated error in the residuals around the stock-recruit relationship. Members considered this a reasonably realistic method for modelling recruitment in North Sea herring.

3. Programs within Excel.

- a. A new spreadsheet for short-term and medium-term predictions was presented to the Working Group (Sparre 1995 WD). This spreadsheet is a development of the program previously used for

providing short-term projections for management purposes, with improved presentation and an extension for calculating projections in future years if future recruitment is specified.

Since this program is built in to a spreadsheet it is possible to alter almost any parameter. However, the only stochastic variable is the recruitment. The spreadsheet appears to be well laid out and easy to use. The spreadsheet is also set up to undertake a stochastic simulation in recruitment, but in its present form the stock parameters at the start of the projection are assumed known precisely.

- b. @Risk. This is a risk analysis and simulation add-in for Excel. The routines available are specifically designed for risk analyses in which it is possible to assign any one of a number of distributions to a variable and thus run simulations with many input variables with specified error-distributions. This appears to be a very powerful tool for medium-term simulations, but no projection spreadsheet for this method had been prepared at the time of the Working Group meeting.

4. Programs used by the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

Two methods were used by Anon (1994b) for the calculation of medium-term projections with uncertainty. One was a nonparametric kernel method, and the other a four-parameter stock-recruit model with autocorrelated errors. The Working Group considered that the use of the kernel method should be considered for herring stocks. The latter method is similar to the 'Beverton and Holt with autocorrelation' model discussed previously, and the differences between the two approaches should in practice be small.

No software was available to the Working Group that would implement these models and also take advantage of the availability of the estimates of the variance-covariance matrix of the population parameter estimates that is calculated in the population models used by this Working Group.

1.7.7 Example of the use of Medium-Term projection methods to address questions of management

1.7.7.1 Introduction

An artificial example was constructed based in a general way on the Division VIa(N) herring assessment, and some trial calculations were made in order to test how

the medium-term methods might be used to address management matters. The calculations made here are intended to test the form in which advice might be given. They are not intended to be used in the management of the Division VIa(N) herring stock.

1.7.7.2 Methodology

In order to assess the risk of different options it is necessary to quantify uncertainty in the population parameters. The Division VIa(N) assessment is heavily dependent on only four years of acoustic surveys of this stock, and no internal estimates of the precision of the surveys are available. It is not possible to assess the precision of the surveys within the assessment method when only five observations are available, hence quantification of risk for this stock is not possible. However, some trial calculations will be carried out in order to demonstrate some potentially useful methods.

Variances about the model were estimated by an iterative reweighting procedure. Beginning with the baseline model fit, the variances of the survey data, and stock-recruit 'observations' about the model were calculated. These variances were then used as estimates of the variances of each type of observation relative to the catch-at-age observations, independently for each age. The procedure was repeated until fishing mortality on the reference age changed by less than 0.5%. The resulting model was thought to be overfitted, but differed by less than 10% from the baseline assessment in terms of fishing mortality at reference age.

Two methods were used to assess uncertainty in the projections: a Monte-Carlo method and a delta-estimator. Both methods use the estimated variance-covariance matrix for the model fit in order to assess the uncertainty in the projected catches. In the Monte-Carlo method, the covariances are ignored and a large number (here, 500) of projections are calculated from pseudo-starting parameter vectors X' , generated as

$$X' = X + e(0, \text{VAR}(X))$$

where X is the vector of parameters estimated by the model and comprising:

- $\ln(\text{Selection})$ at age
- $\ln(\text{Fishing mortality})$ at reference age by year
- $\ln(\text{Population numbers})$ at age
- $\ln(\text{Parameters of the Beverton and Holt stock-recruit relationship})$.

and $e(0, \text{VAR}(X))$ represents a pseudo-random variate with mean 0 and variance equal to the estimated variance of X . Percentiles of the distributions of the pseudo-projections are then used to assess the expectations of the projected parameters.

The delta-method estimator essentially relies on the assumption that the variance of the projected populations can be approximated from a linear combination of the covariances of the input parameters. The method has been described in Anon. (1995) In both cases natural mortality and weights at age in stock and catch have been assumed known precisely. Recruitments in future years are estimated from the Beverton and Holt stock-recruit relationship, the parameters of which are estimated at the same time as the other parameters in the assessment, and the variability of recruitment about the function is estimated in the variance-covariance matrix for the model fit.

Either method can be used under conditions of constrained catches, in which case a probability distribution for the fishing mortality can be derived, or conversely under conditions of constrained fishing mortality, in which case the distribution of catches can be assessed. In either case a probability distribution for spawning stock biomass can be calculated. Both methods can be used to address questions of risk associated with short-term catch options, and of the implications of multiannual fixed-catch and fixed-effort projections.

1.7.7.3 Comparison of methods

Both the Monte-Carlo and the delta methods have been used to assess the risks associated with a range of catch options in 1995 to 1997. The risk assessed is the probability that the spawning stock size in the projection years will be lower than the estimated spawning stock size in 1994 (which for this purpose is assumed known precisely). Catches were assumed to be constant in the three years, over a range from 30,000 to 85,000 t. Results are given in Table 1.7.1. Under these circumstances the two methods yielded closely similar estimates of risk. The Monte-Carlo method suffered from disadvantages of much longer processing time, and the method also failed in cases where the catch constraint was large in relation to the stock size, as in some iterations unrealistically high F -multipliers were required in order to reach the catch constraint. For these reasons, subsequent analyses were calculated using the delta method.

1.7.7.4 Response of stock to management action

The immediate management action to be considered for this stock is thought to be the application of a projected catch for 1996. It is stressed that no good estimates of the variances of the population estimates are available and calculations presented here are illustrative only.

Here, recruitment in 1994 at age 2 is estimated from the acoustic survey but recruitments in 1995 and later are calculated on the basis of the fitted Beverton-Holt stock-recruit relationship. Fishing mortality in 1995 is calculated on the basis of *Fstatus quo*.

No minimum biologically acceptable level has been defined for this stock. In consequence, the concept of risk of a stock decline is dependent on the level above which it is desired to maintain the stock. The delta-method was used to calculate the risk of the stock declining below each of a range of stock sizes, for each of a range of TAC options (Figure 1.7.2.). Three risk ogives from this surface describing the risk of the SSB falling below 200, 250 or 300 thousand tonnes have been plotted, for a range of TAC options for 1996 ranging from 30,000 to 90,000 t (Figure 1.7.3.).

1.7.7.5 Medium-Term projections

Medium-term projections have been calculated with a view to describing the probable development of the stock under conditions of stable fishing mortality at recent levels. Two trajectories of stock and catches have been calculated for (1) Constant fishing mortality at levels of the 1994 estimate, and (2) Constant fishing mortality at levels of the mean of estimated fishing mortalities from 1990 to 1993. This latter range is arbitrarily chosen and is a period of slightly higher mortality in this stock. Results are given in Figure 1.7.4., which shows results generally similar to those estimated in the previous assessment of this stock. The spawning stock biomass is likely to decrease until about 1997. Stock biomass may increase thereafter but the projections become extremely uncertain and it is hard to predict what may happen after about 1998. The two levels of fishing mortality modelled (= 0.1584 and 0.282) show only a small difference in the probable trajectories of the stock.

The probable decline of the spawning stock even under conditions of low fishing mortality can be explained from the present age-structure of the stock. The year class of 3-ringers is particularly strong, and the corresponding recruitment is estimated as being the strongest since 1987 and the fourth strongest since 1975. When 'normal' recruitment (as derived from the Beverton and Holt stock-recruit relationship) is assumed for future years, it is not surprising that stock biomass is projected to fall as the strong 1987 and 1992 year classes leave the fishery.

1.7.7.6 Evaluation of multiannual catch options

Multiannual catch options could be interpreted as

- (1) setting TACs for some years in advance,

or

- (2) defining a management rule or control law such that a TAC is set on the basis of the current assessment and some predefined regimen that leads to a TAC.

The subject is clearly complex and involves many management considerations which are outside the usual remit of the Working Group. The approach taken here is to present some example calculations based on each of the two approaches in the context of the medium-term projections. For comparative purposes, the risk associated with two approaches to multiannual catch options have been calculated. The starting assumptions on which both calculations are based are:

- (1) Assessment based on iteratively-reweighted model fit;
- (2) *F* status quo in 1995;
- (3) Weights at age taken as means from 1992-1994;

The two options which are compared here are:

- (1) - A constant-catch approach, in which catches in 1996, 1997 and 1998 are assumed equal; This corresponds to setting a TAC for some years in the future.
- (2) - A constant-F approach, in which fishing mortality in 1996, 1997 and 1998 is assumed equal; This corresponds to establishing a management rule in which the stock is assessed and a TAC is set annually on the basis of keeping fishing mortality at some defined figure.

The performance of the two options are compared on the basis of:

- (1) The projected spawning stock size in 1998;
- (2) The lowest 5% limit of the distribution of the spawning stock size in 1998;
- (3) The total yield over the period.

Results are given in Figure 1.7.5. These show that on the basis of a comparison of yield against expected spawning biomass there is little to choose between the two options. On comparing yield with the lowest spawning biomass that could reasonably be expected (the lowest 5% limit of the SSB distribution), it is apparent that fishing at constant *F* is better at maintaining a higher spawning stock than the constant-catch strategy. The difference is only slight for low catch levels, but becomes more important at higher catch levels.

Results of this analysis suggest that there may be only a small benefit in attempting to apply a constant fishing mortality over a three-year period. Unless much higher levels of fishing mortality are exerted, and over the three years of the projections considered here, protection of the spawning biomass appears to be almost as well served by a three-year constant catch strategy as by a constant *F* strategy. Management comment on this comparison of options is invited.

1.8 Biological Sampling and Landings Statistics

1.8.1 Introduction

There have always been uncertainties about the quality of landings statistics and these have increased over the latest 10 years. For many countries the quality of the biological samples collected from the commercial landings have been varying. These problems have to be resolved.

For most countries, landings figures are collected by the national authorities. Normally, information comes from sales slips and logbooks. The accuracy of this information often varies because there are problems with area misreporting when quotas are almost used up and with by-catch regulations and the need to spread the quotas over the year. Discards in the pelagic fishery also become more common due to market problems and quotas which means that only the highest quality of fish are landed.

It is essential for assessments to be based on accurate landings statistics and it is the responsibility of the national authorities in each country to provide these. This Working Group felt it was necessary to try to produce a protocol on how to get the most precise landings figures and how the effort, which is being put into the national biological sampling programme, can be used in the best way.

1.8.2 Landings statistics

Many attempts to estimate misreporting and the amount of discards have been made. This Working Group felt it necessary to have a detailed description of how the present monitoring system in each country works and of the effectiveness of current catch controls.

Some ideas could be to:

- Compare the total fish fillet and roe production from various factories with official landings data.
- Estimate total catch from sub-sampling procedures. These samples could for instance be obtained from observers on board vessels in connection with discard investigations. Furthermore, it might be possible to merge these data with logbook data on days at sea. A potential problem is, however, whether fishermen will behave "normally" when observers are on board.
- Estimate the individual landings and species reported from "neighbouring" areas and reallocate them to the correct area and species.

In the attempt to try to solve these problems the Working Group suggests that the following topics should be described for each country:

- **Description of the fisheries in which herring and sprat are caught.**
 - Fleets, gear-type, mesh-size etc.
- **Regulations pertaining to the fisheries for herring and sprat in each area.**
 - Licences, technical regulations, quotas, closures, by-catch regulations etc.
- **Description of the national authorities' monitoring system.**
 - Uses of logbooks, sales slips, port and sea control, registration of data (who and how).
- **Evaluation of the national authorities' monitoring system for management purposes.**
 - Problems of errors in the system, differences between official landings figures and figures used in Working Groups.

1.8.3 Biological sampling.

For many countries the biological sampling programmes of commercial landings have improved over recent years but are still below the recommended level in many areas. Therefore the sampling level and the quality of the samples should be improved. No regular monitoring programme for discards is being carried out by any country.

At present, there are many problems such as:

- Obtaining samples from landings at ports outside the country of origin of the fishing vessel.
- Not all fleet/fisheries/quarters and types are sampled.
- Samples taken do not reflect the catches in different seasons.
- No samples are taken from the discarded parts of the catches.
- Errors in age-determination and reliable methods for separating different adjacent herring stocks.

The Working Group felt that it is important to have a detailed description of each national sampling programme in order to organize international collaboration. Furthermore, it is essential to have this information available when compiling data within this Working Group.

In an attempt to solve these problems the Working Group felt that following topics should be described for each country:

- **The biological sampling system of commercial landings of herring and sprat.**

- **The biological sampling system of commercial landings of herring and sprat.**
 - What is collected and how. Which information is used (sales slips, logbooks etc.) What is recorded and how.
- **The use of the biological sampling system of commercial landings for assessment purposes.**
 - How are the samples analyzed. How are the samples used to calculate catch in numbers by age etc.
- **Evaluation of the biological sampling system of commercial landings for assessment purposes.**
 - Uncertainties, etc. Possible errors.

Currently all countries are measuring and ageing a large number of fish and all data are held by national institutes. This is an extremely large task which very often leads to a duplication of effort. To make this whole operation more effective it is important to consider ways of maximizing the information obtained from the data.

One approach could be to make international age/length keys for each area by month or by quarter. Each country could then be responsible for sampling otoliths for a specific area with an overlap with a least one other country. Then, the number of otoliths to be read could be reduced with more effort put into improving data quality. For example, more samples could be collected, otolith readings could be checked and more length measurements made of fish from landings from different fleets irrespective of the origin of the vessel.

The Working Group agreed that a Sub-Group of the Working Group should be established with the task of trying to produce:

- an overall evaluation of the present landing statistics and the biological sampling.
- ideas and suggestions to improve current systems.

This Sub-Group should work by correspondence and report to the next Working Group Meeting in 1996.

The Working Group has elected J. Dalskov as Chairman and he will contact other members of the Working Group for information as required.

Table 1.4.1 a The prevalence of *Ichthyophonus* in Divisions IV a,b,c and VII d in 1994 from research vessel surveys.

	UK England		UK Scotland		Netherlands		Norway	
Division	Examined	Infected	Examined	Infected	Examined	Infected	Examined	Infected
IVa	608	2	2096	6			2219	30
IVb	797	nil	1030	nil				
IVc/VII d	6	nil						
Unspec.					2967	nil		

Table 1.4.1 b The prevalence of *Ichthyophonus* in Divisions IV a / IV b in 1994 from commercial vessel catches

	UK Scotland		Norway	
Division	Examined	Infected	Examined	Infected
IV a	1958	nil	2919	3
IV a / IV b	7267	7		

Table 1.4.2 a The prevalence of *Ichthyophonus* in The Skagerrak, Kattegat and The Sound from research vessel surveys and commercial sampling by Sweden in 1994.

1994	Skagerrak (SD 20)	Skagerrak (SD 20)	Kattegat (SD21)	Kattegat (SD21)	The Sound (SD23)
	Research	Commercial	Research	Commercial	Research
No. examined	2675	1212	2278	2769	541
No. infected	51	8	10	4	1
% infected	1.9	0.7	0.4	0.1	0.2

Table 1.4.2 b The prevalence of *Ichthyophonus* in the Kattegat in 1994 from an additional series of observations reported by Sweden.

Research vessel surveys				
	> 29 cm	25 - 29 cm	20 - 24 cm	< 20cm
No. examined	99	574	1047	2208
No. infected	0	8	13	27
% infected	0	1.4	1.2	1.2

Commercial catches				
	> 29 cm	25 - 29 cm	20 - 24 cm	< 20cm
No. examined	153	1077	1989	860
No. infected	1	1	2	0
% infected	0.7	0.1	0.1	0

Table 1.4.3 The prevalence of *Ichthyophonus*, by age group, in the Norwegian Skagerrak from a research vessel survey in February 1994.

Age (winter rings)	3	4	5
No. examined	124	35	11
No. infected	13	2	1
% infected	10.5	5.7	9.1

Table 1.4.4. The prevalence of *Ichthyophonus* in the Irish Sea and Icelandic waters from research vessel sampling by UK (England) and Iceland respectively, during 1994.

	Irish Sea	Icelandic waters
No. examined	110	1489
No. infected	0	4
% infected	0	0.3

Table 1.4.5 Percentage of herring infected with *Ichthyophonus* by age. Results from Norwegian surveys (N) presented in Skagen (WD, 1995, and from international acoustic surveys presented in Simmonds *et al.* (WD, 1994) (A).

Age	Summer 91(N)	Autumn 91(N)	Summer 92(N)	Summer 92(A)	Autumn 92(N)	Summer 93(N)	Summer 93(A)	Autumn 93(N)	Summer 94(N)	Autumn 94(N)
1	3.8	-	-	0	0	0.1	0	0	0	0
2	4.7	-	4.0	0	0	0.8	0.1	0.5	0	1.3
3	6.3	6.5	10.4	0.72	3.4	0	0.6	0	0	2.1
4	23.5	24.2	5.8	4.96	5.0	2.3	3.4	2.1	2.1	6.7
5	30.5	18.2	28.7	12.28	7.1	0.6	8.3	4.3	0	0
6	53.1	8.0	31.4	14.09	8.7	12.4	5.0	6.7	2.7	3.3
7	54.6	16.7	32.7	-	8.9	13.6	3.0	7.0	11.1	2.4
8	-	-	52.9	11.29	4.8	14.3	4.8	0	16.2	0
9	-	-	16.0	-	-	20.0	6.9	5.3	35.7	0

Table 1.4.6 The prevalence of *Ichthyophonus*, by age group, in the Norwegian commercial catch samples (purse seine & trawl) in 1994.

Age	0	1	2	3	4	5	6	7	8	9+
No. examined	0	0	1841	465	156	179	121	82	87	48
No. infected			1	1	1	3	2	7	1	1
% infected			0.1	0.2	0.6	1.7	1.7	8.5	1.1	2.1

Table 1.5.1 Herring. IBTS preliminary (except for Q1 1991-1994 where it is final) indices based on standard areas.

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0	-	118	673	1655	-	160	3103	3512	-	103	4716	6500	-	13	1857	4310	-
1	2433	5490	6352	662	2099	6689	1316	1170	1995	3817	999	272	2823	5627	2311	1020	2020
2+	826	1168	298	11	974	703	360	223	841	905	910	81	1156	415	1783	127	3216

Herring. Final Indices.

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0	-	0	650	2039	-				-				-				
1	2433	4426	6521	750	2099				1995				2823				
2+	826	1855	304	10	974				841				1156				

Herring. Total mortality estimates

$$Z \text{ values} = \text{LN} [(n(\text{age, year})+1)/(n(\text{age}+1, \text{year}+1)+1)]$$

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0		-4,03	-0,67	0,35		-3,17	1,13	2,55		-3,99	0,71	1,85					
1+	0,91	2,05	2,87	1,09	0,91	2,00	0,37	2,66	0,55	2,22	-0,58	0,7	-0,13				

Table 1.5.2

Sprat. IBTS preliminary (except for Q1 1991-1994 where it is final) indices based on standard areas. In Q3 1994 0-group are included in the 1-group index.

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0	-	0	0	1565	-	0	49	3584	-	1	1503	4825	-	120	0	3400	0
1	1121	485	354	5610	1561	2290	6141	11196	1692	9333	3713	13917	4003	2531	4117	13241	2724
2+	147	1434	286	385	384	3619	1615	601	674	3865	394	86	1498	954	270	145	1210
Sum	1268	1919	640	7560	1945	5909	7805	15381	2366	13199	5610	18828	5501	3605	4387	16786	3934

Sprat. Final Indices.

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0	0	0	33	1601	0				0				0				
1	1121	1144	406	5032	1561				1692				4003				
2+	147	614	203	1611	384				674				1498				
Sum	1268	1758	642	8244	1945				2366				5501				

Sprat. Total mortality estimates.

$$Z \text{ values} = \text{LN} [(n(\text{age, year})+1)/(n(\text{age}+1, \text{year}+1)+1)]$$

Year of sampling	1991				1992				1993				1994				1995
Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
0		-7,74	-8,72	-1,97		-9,14	-4,31	-1,36		-7,14	-1,01	-1,01					
1+	1,07	-2,01	-1,52	2,23	0,84	-0,52	2,74	4,86	0,12	2,28	2,62	4,56	1,20				

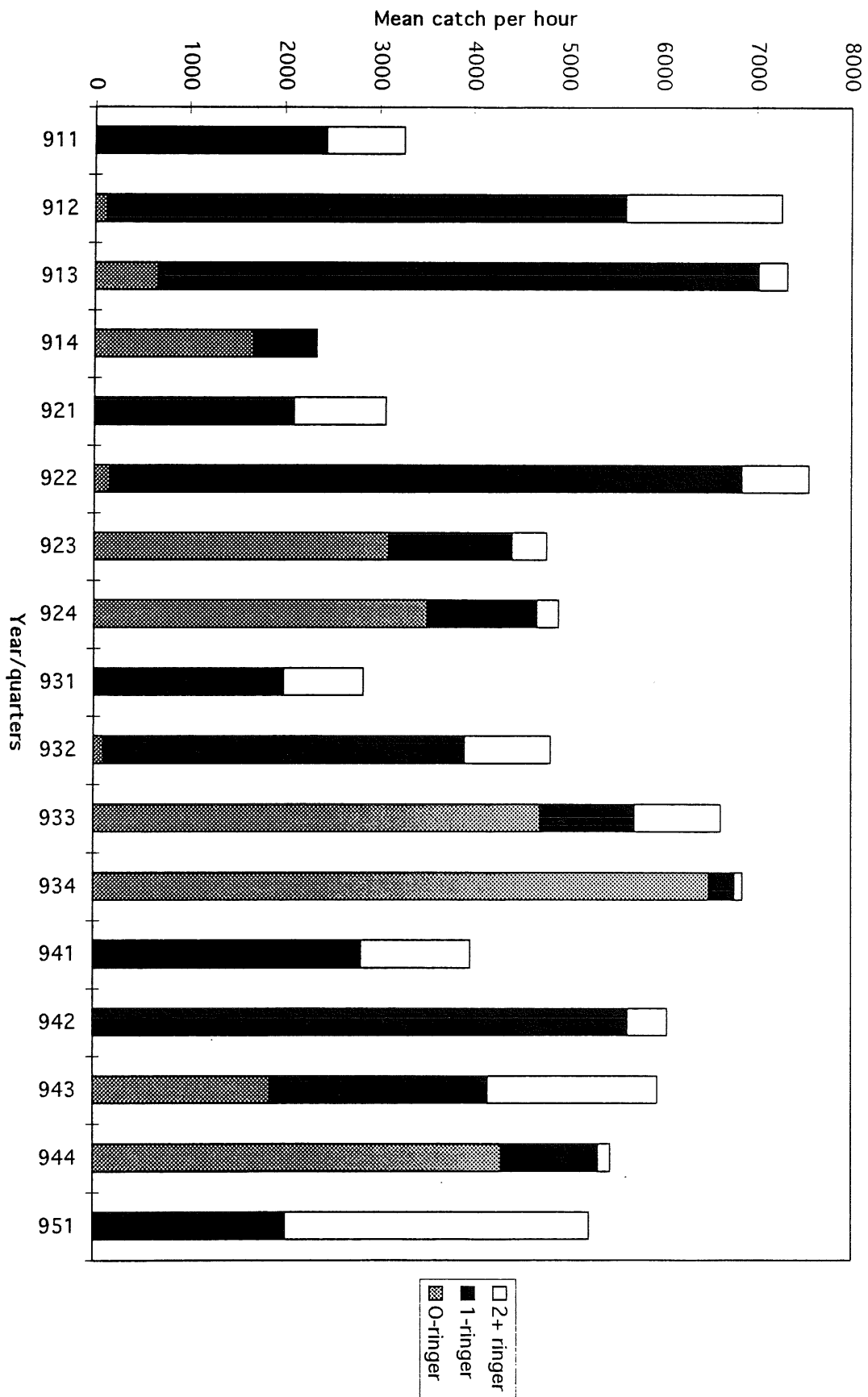
Table 1.7.1. Estimates of the probability that spawning stock size in the years 1995 to 1997 will fall below the estimated stock size in 1994, for a range of catch constraints over those three years. Estimates from either Monte-Carlo or delta methods.

Catch Const- raint	Delta Method			Monte-Carlo Method		
	1995	1996	1997	1995	1996	1997
30 000	.27	.35	.86	.21	.27	.80
35 000	.31	.47	.94	.26	.42	.89
40 000	.36	.59	.98	.31	.54	.94
45 000	.42	.71	.99	.37	.68	.97
50 000	.47	.80	.99	.43	.76	.99
55 000	.53	.88	.99	.49	.82	.99
60 000	.58	.93	.99	.55	.88	.99
65 000	.63	.96	.99	.61	.92	**
70 000	.69	.98	.99	.64	.94	**
75 000	.73	.99	.99	.71	.95	**
80 000	.78	.99	.99	.75	**	**
85 000	.82	.99	.99	**	**	**

** - Some iterations failed on account of low stock sizes in relation to the catch constraint.

Figure 1.5.1

IBTS Herring indices by quarter



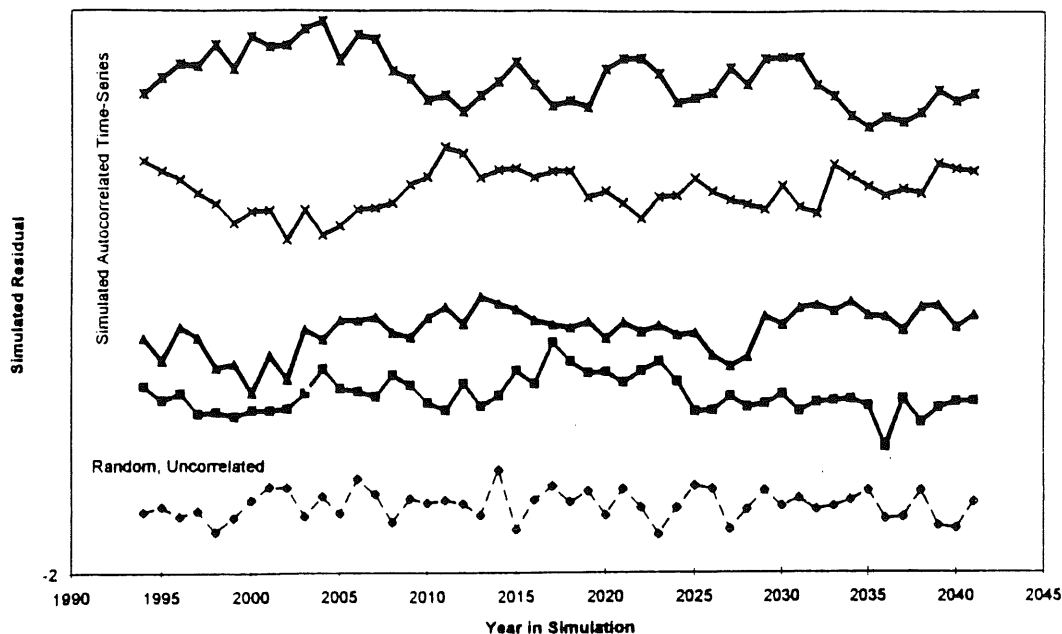


Figure 1.7.1. Some examples of randomly-generated autocorrelated time series of residuals about the fitted Beverton and Holt stock-recruit relationship. Four autocorrelated time-series are plotted together with an uncorrelated time series for comparison.

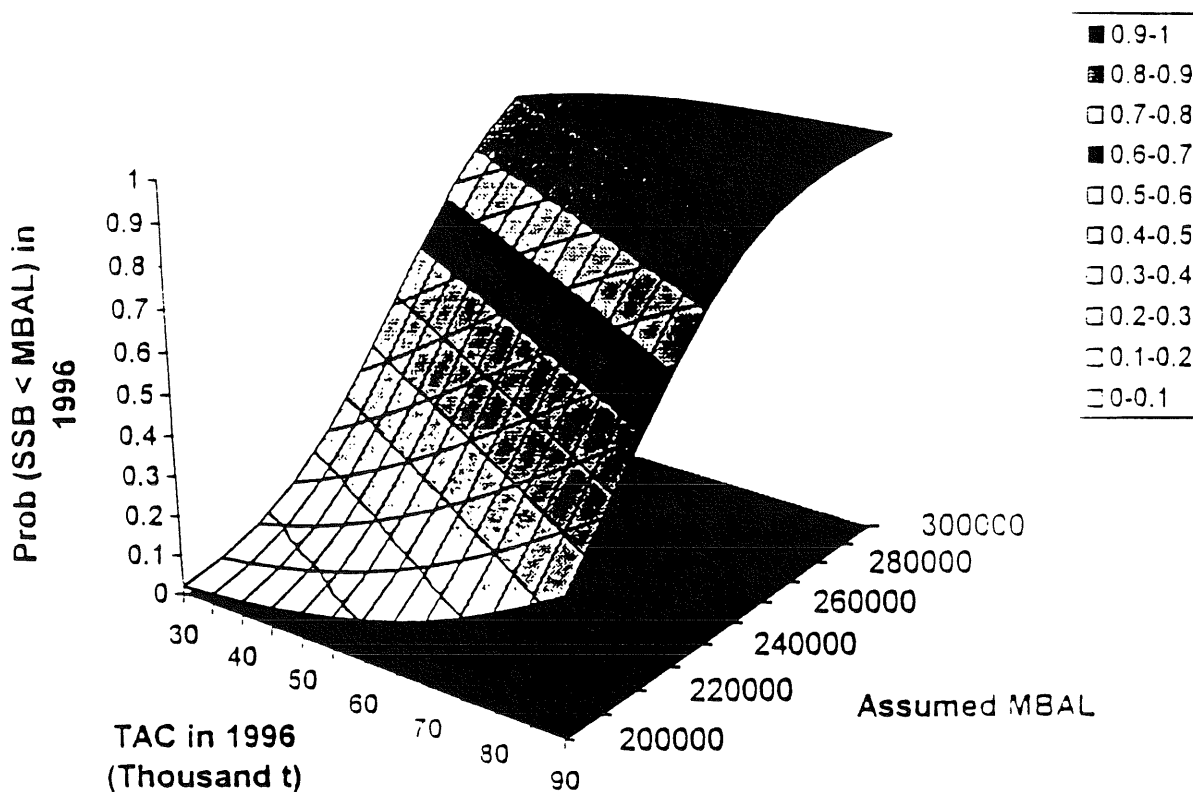


Figure 1.7.2 The surface plotted is the estimated probability (on the height axis) that spawning stock size will fall below a level (on the right-hand axis) when the TAC in 1996 is set at the level on the left-hand axis. The probability may be thought of as a measure of the risk that the stock size will fall below MBAL. It depends on both the assumed value of MBAL, and the chosen TAC. The surface slopes from a low 'risk' if MBAL is assumed low and the TAC is low; to a high 'risk' if a high MBAL is assumed and a high TAC is taken.

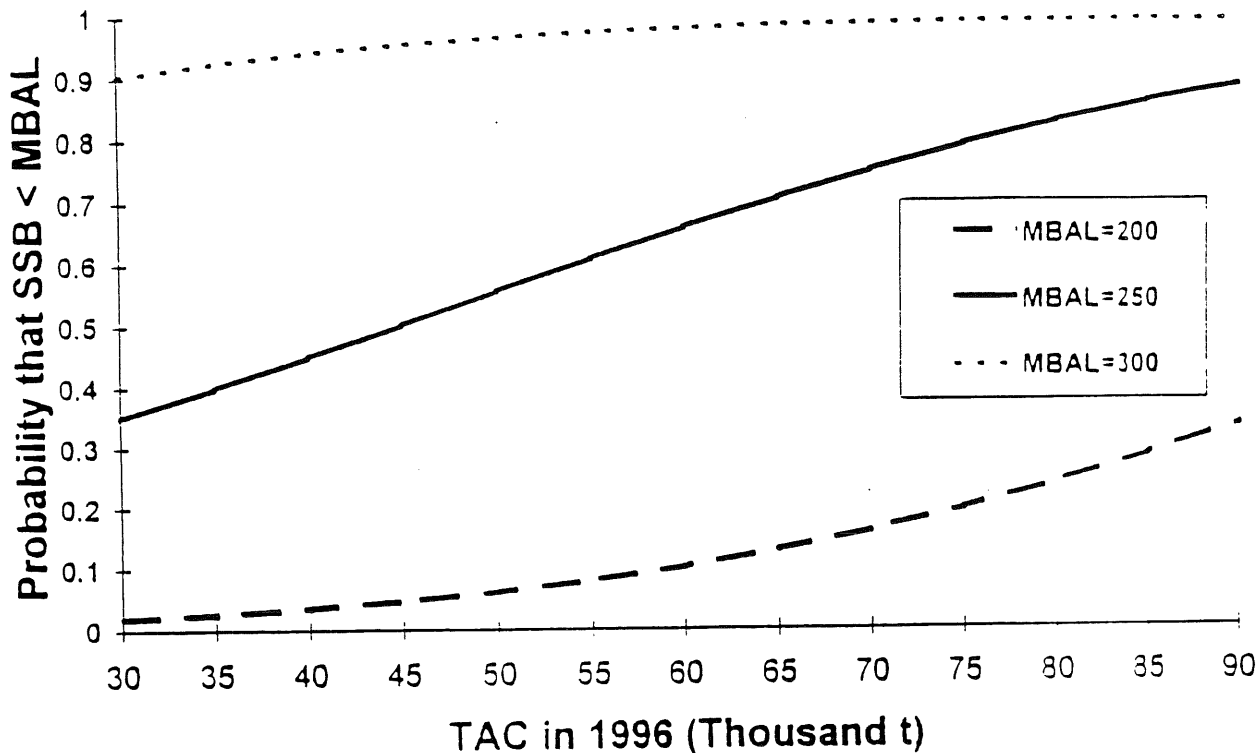


Figure 1.7.3. Estimated probability that the stock size will fall below an assumed MBAL, depending on the TAC taken in 1996. Three lines are plotted for MBAL = 200 000, 250 000 or 300 000t.

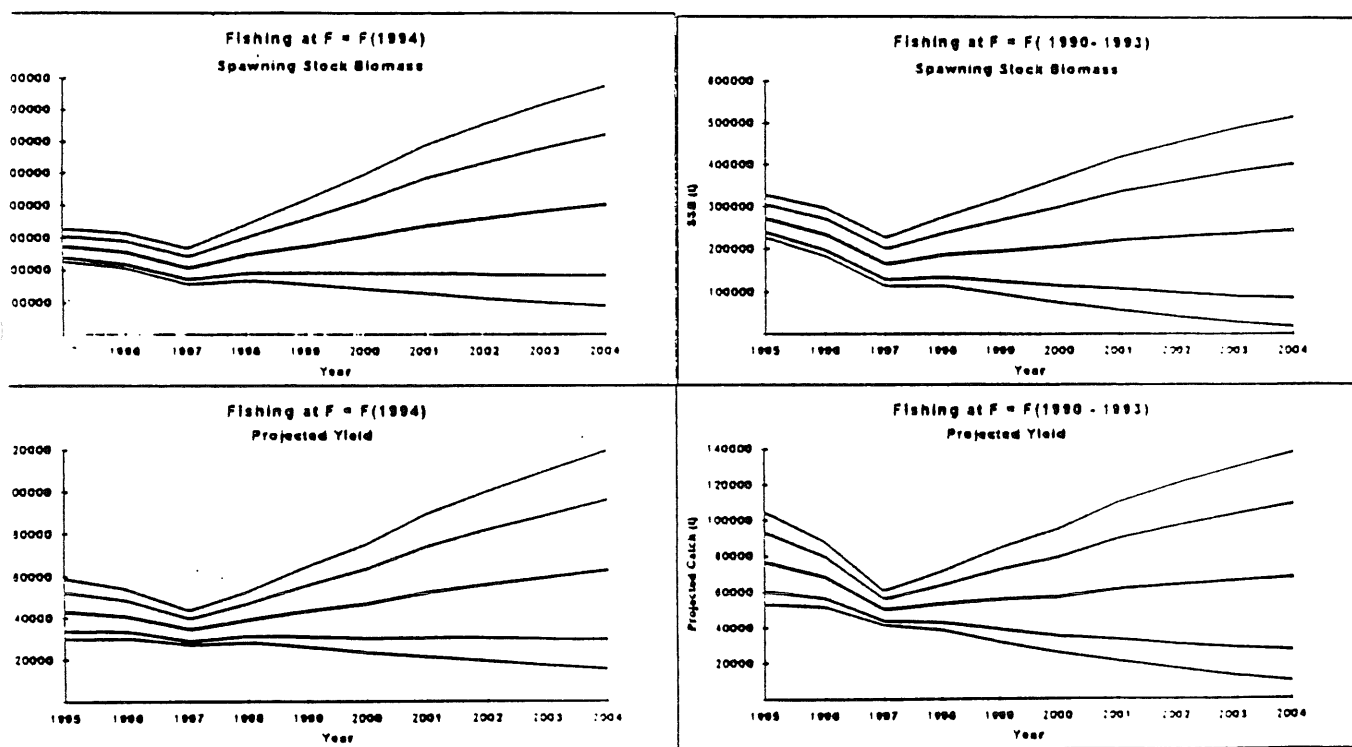


Figure 1.7.4. Medium-term projections of yield and spawning stock biomass under two levels of fishing mortality. Solid lines show 5, 25, 50, 75 and 95 percentiles. The thickness of the line indicates the probability level: the thicker the line the more likely the outcome. No MBAL has been defined for this stock.

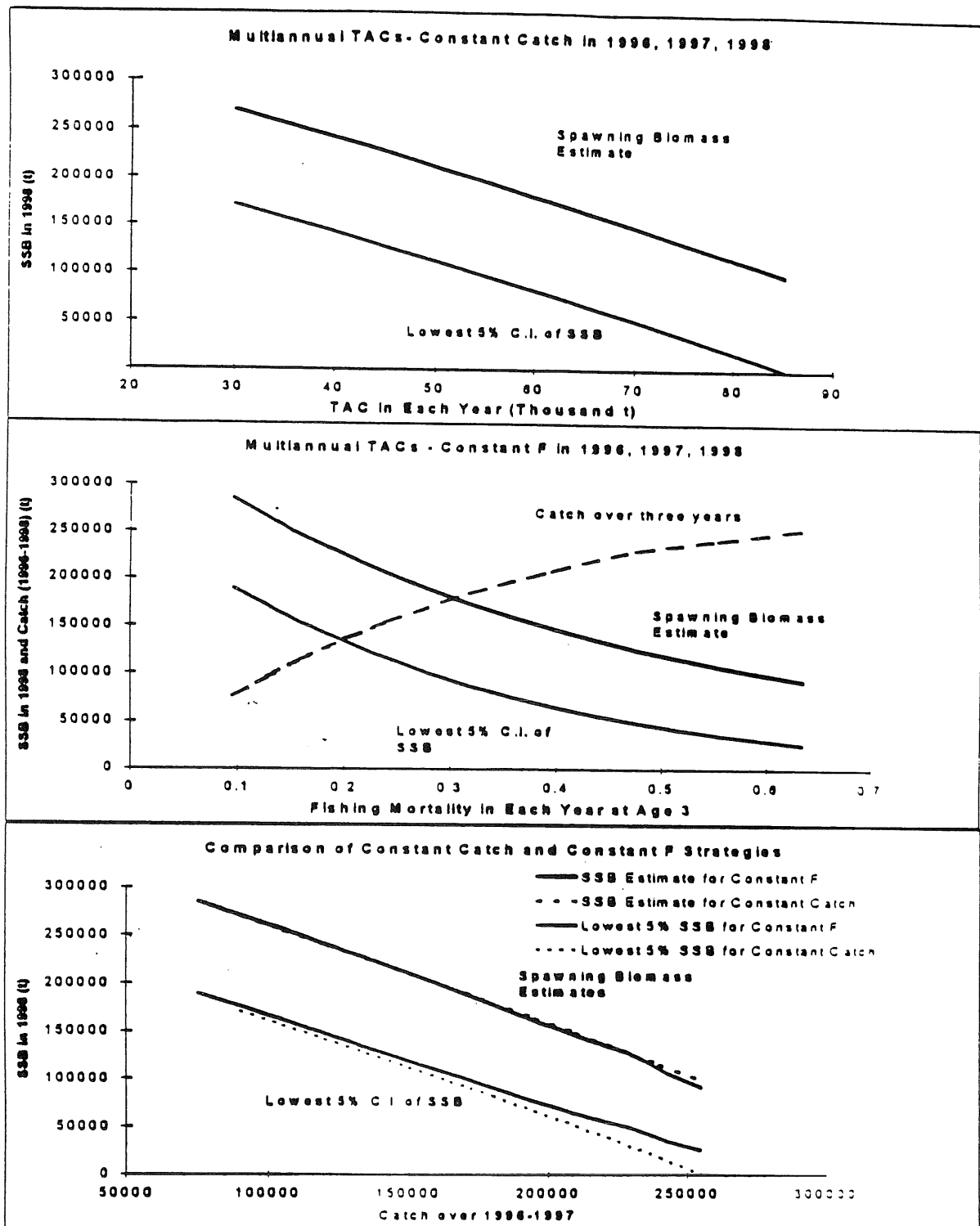


Figure 1.7.5. Comparison of constant-catch and constant-F management. Top, response of spawning stock biomass (SSB) in 1998 to taking equal catches in 1996, 1997 and 1998 of different amounts. The most likely SSB is plotted, together with its lower 5% confidence interval. Centre, response of SSB to exerting equal fishing mortality in 1996, 1997 and 1998 at different levels. Catches, SSB and the lower 5% confidence interval are plotted. Bottom, comparison of the two strategies. For equal catches in the three-year period, the two approaches lead to similar SSBs in 1998, but the lower 5% confidence interval is lower for the constant-catch strategy.

2. NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1994 and 1995

1994

Again at the 1993 ACFM meeting there were presented a small number of scenarios of catch options for the five different fleets exploiting North Sea herring but no recommendation for a specific TAC was given. It was stated that the SSB has been fairly stable, fluctuating between 1.0-1.8 million t. The stock was therefore considered to be within safe biological limits. Yield-per-recruit calculations based on the present exploitation pattern indicate that there are no long-term gains when fishing mortality is in excess of 0.3.

ACFM also reiterated that catches of juveniles, both in the North Sea and Division IIIa, substantially reduce the long-term yield of adult herring and the spawning biomass.

For the southern North Sea and Channel (Downs herring) it was stated that a catch in 1994 at the same level as the TAC for 1993 (50,000 t) is expected to allow the stock to remain at a fairly stable level.

The TACs adopted by the management bodies for 1994 are: Divisions IVa,b: 390,000 t; Divisions IVc and VIId: 50,000 t.

1995

At its November meeting in 1994 ACFM noted that the spawning stock biomass has declined since 1989 but stated that the stock was above MBAL and advised that an increase in long-term yield could be achieved by reducing the fishing mortality for this stock.

ACFM noted that the catches of juveniles in 1992-93 reached the highest levels of the early 1980s and that such an exploitation pattern will endanger the future spawning stock biomass. A closure of all fisheries in Sub-area IV and Division IIIa landing herring as by-catch would result in a long-term net gain in the order of 23% in total yield and 98% in spawning stock biomass when mean recruitment was assumed.

Again at the 1994 ACFM meeting there were presented a small number of scenarios of catch options for the five different fleets exploiting North Sea herring but no formal TAC advice was given.

The forecast for 1995 for North Sea autumn spawners taken in the North Sea and in Division IIIa using the

same fishing mortality in 1995 as in 1993 will give a total catch of 655,000 tonnes, where 555,000 tonnes should be taken in the North Sea and 100,000 tonnes in Division IIIa.

For the southern North Sea and Channel (Downs herring) it was stated that a catch in 1995 at the same level as the TAC for 1994 (50,000 t) is expected to allow the stock to remain at a fairly stable level.

The TACs adopted by the management bodies for 1995 are: Divisions IVa,b: 390,000 t; Divisions IVc and VIId: 50,000 t.

2.1.2 Catches in 1994

Total landings in 1994 are given in Table 2.1.1 for the total North Sea and for each division in Tables 2.1.2 to 2.1.5.

The total catch in 1994 of 468,000 t is lower than in previous years when the catch level has been around 540,000 t. The decreasing catch level is due to a reduction in Danish landings. There has in recent years been more and more effort put into reducing the by-catch of herring in the small-meshed fishery. In 1994 the by-catch level of herring in the sprat fishery was very low due to a large sprat stock. As the by-catches of herring in the small-meshed fishery (38,000t) are not counted against the TAC, some countries did not fill their quota. The 1994 catch exceeded the TAC by 28,000 t. In previous years the TACs were exceeded by: 1993 94,000t, 1992 143,000t and 1991 147,000t.

Misreporting of landings also occurred in 1994. Danish human consumption landings reported as having been taken in the Skagerrak have been transferred to the North Sea. There are also indications which show that there may be misreporting of landings taken in the North Sea but reported as taken in Division VIa North (see Section 5). Again this year, unallocated landings are listed but the magnitude of these landings has been reduced. Discards and slipping also occur in the North Sea due to market conditions and due to stretching of quotas. This amount is not known and could in some seasons be substantial.

As in previous years, Norwegian catches of Norwegian spring spawners (counted against another TAC) were removed.

In Divisions IVc and VIId, the estimated catch of close to 71,000 t is 11,000 t lower than in 1993 but at the same level as in 1992. The landings exceeded the TAC by 21,000 t for that area. The 1994 catch includes estimated discards of 2,400 t from only the Dutch fleet during the herring season (November-December).

2.2 Biological Composition of the Catch

2.2.1 Catch in number and weights at age

Quarterly and annual catches in numbers and mean weights at age were compiled for each division and for the total North Sea. Table 2.2.1 provides a breakdown of numbers caught by age group for each division on a quarterly and annual basis for 1994. Table 2.2.2 presents a comparison of total North Sea catches in numbers at age over the years 1970-1994.

The catches in numbers of Division IIIa-Western Baltic spring spawners caught in the North Sea in 1987-1994 and transferred to the assessment of the Division IIIa-Western Baltic stock are presented in Table 2.2.3. The estimated numbers of North Sea autumn spawners caught in Division IIIa in 1987-1994 and transferred to the North Sea assessment are given in Table 2.2.4. Table 2.2.5 summarises the total catch in numbers at age of North Sea autumn spawners used in the assessment.

The total catch in number in the North Sea in 1994 (6.8 billion) is 4 billion less than in 1992 and 1993. In 1994 the catch of 0-ringers (3.7 billion) has been reduced compared to 1992 and 1993 when the landings of 0-ringers were 7.6 billion and 7.0 billion respectively.

In 1994 the 2-ringers were predominant in Divisions IVa and IVb (Figure 2.2.1). In previous years catches in this area consisted predominantly of 3-ringers and older (especially year classes 1985 and 1986). Figure 2.2.2 shows the age composition in the Southern North Sea where in 1994 3-ringers and older were predominant in the landings.

The contribution of 1-ring herring to the total catch in number was 19% and this is the lowest landing in number of this age group since 1980 (Table 2.2.2). The mean catch of 1-ringers in the period 1980-1993 was 1.3 billion, while the landings in 1994 were 0.45 billion and in 1993 1.3 billion.

Catches of juvenile North Sea autumn spawners were also taken in Division IIIa. These catches (0.5 billion 0-ringers and 1.2 billion 1-ringers) were much lower than the two previous years. The total catch of 0- and 1-ringers in 1992 and 1993 were among the highest recorded and this reduction in catch of young herring indicates a major change in exploitation pattern in the fisheries. As in the North Sea the reduction in the catch of juvenile herring is probably related to high abundance of the sprat stock, which provided an alternative target for the fishery. The strength of the 1985 year class is still apparent and the catch in number of 8-ringers is the highest since 1970 (Table 2.2.2).

The percentage age composition of 2-ringers and older by sub-division and quarter for 1994 is given in Table

2.2.6 and the SOP by age and division for each quarter is given in Table 2.2.7.

Table 2.2.8 gives the age compositions separately for the catch in the human consumption fishery (fleet A), the small-mesh industrial fishery (fleet B) in the North Sea, the human consumption fishery in Division IIIa (fleet C), the mixed clupeoid fishery in Division IIIa (fleet D) and other landings for industrial purposes in Division IIIa (fleet E). It should be remembered that fleet B refers only to Denmark while it was not possible to split the small-meshed catches from Norway. Norwegian small-meshed catches are included in fleet A.

2.2.2 Quality of catch and biological data

The relationship between official and actual catches is not known. Estimates of discards were provided by only one country, but discards occur in the fisheries of most countries and could be a considerable amount. As the market conditions have varied no indication of a declining trend in discarding should be expected. The high abundance of 2-ringers in 1994 may have caused relatively high discarding of this age group but no data were available to support this assumption.

In 1994 there were indications of a considerable amount of misreporting from one area to another, especially from Division IVa to Division VIa and from Division IVa to Division IIIa. Some of the landings reported as taken in Division IIIa have been transferred back to Division IVa. The landings reported as taken in Division VIa and believed to have been misreported were not transferred to Division IVa as they amounted to 22,000t.

The decrease in landings in the small-meshed fishery were partly due to a very good sprat fishery, which gave the fishermen an alternative for juvenile herring and where it was possible to avoid small herring as by-catch.

Sampling of commercial landings for age, length and weight was low in some fisheries and in other fisheries no samples have been taken at all (Table 2.2.9). So, again this year uncertainties in landings figures can be expected.

The Working Group therefore still strongly recommends that adequate sampling be conducted of herring in all fisheries in the North Sea where clupeoids are caught.

2.2.3 Treatment of spring-spawning herring in the North Sea.

Norwegian spring-spawners are taken close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal spring-spawners in the southern North Sea are caught in small quantities in most years. These catches are given in Tables 2.1.1 and 2.1.5. With the exception of 1990,

these catches are included in the assessment of the North Sea autumn-spawners.

Western Baltic and Division IIIa spring-spawners are taken in the deeper parts of the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1. The table specifies the estimated amount of Division IIIa/Western Baltic spring-spawners which are transferred from the North Sea assessment to the assessment of the Division IIIa/Western Baltic. The methods of separating these fish are described in former reports from this Working Group.

The method assumed that the mean vertebral count for the autumn spawners is 56.5 and for spring-spawners 55.80. The fractions of spring spawners (fsp) are estimated from the formula $(56.50-v)/0.7$, where v is the mean vertebral count of the (mixed) sample. The

method is quite sensitive to within stock variation (e.g. between year classes) in mean vertebral counts. The same method has been applied to separate the two components in the summer acoustic survey.

As no samples were taken in the transfer area in June and August 1994, the two samples from May (Figure 2.2.3) have been used to compute the proportion of spring-spawners caught during the second quarter (April and May), and the 11 samples from July (Figure 2.2.4) were used to compute the proportion of spring-spawners caught during the third quarter (July and August). A total of approximately 2000 specimens were sampled for this purpose.

The resulting proportion of spring-spawners and the quarterly catches in the transfer area in 1994 are as follows:

Proportion (%)

Quarter	2 - ring	3 - ring	4 + ring	No of rectangles sampled	Catch in transfer area (t)
Q.2	0	15	58	2	10693
Q.3	14	76	80	11	21256

The quarterly age distribution in Sub-division IVa (E) was applied to the catches in the whole area. The number of spring-spawners by age were obtained by applying the estimated proportions by age.

2.3 Recruitment

2.3.1 The IBTS index of 1-ringer recruitment

The 1-ringer index is now based on the IBTS surveys (GOV) in the entire survey area, using means of daytime-catches within all statistical rectangles sampled in the February survey. In the calculation of the recruitment index the sampling within rectangles is, however, down-weighted if rectangles include significant areas unlikely to contain 1-ringers (areas of water depth <10m and >150m). At the present meeting a revision of the 1-ringer index used previously was proposed. The following revisions were made: 1) the weighting of rectangles is based on a more detailed set of weighting factors (see Fig 2.3.1), 2) unsampled rectangles are allocated the mean catch rate estimated within "Roundfish areas" and 3) the index is expressed as the mean catch rate (number per hour) for the entire

survey area. These procedures are included in the ICES standard retrieval from the IBTS database.

The revision of the calculation procedures did not in general change the relative magnitudes of indices. Only the index of the 1991 year class showed a significant change (increase) compared to the earlier index values. This is due to the change of the weighting factors used in the Skagerrak/Kattegat, while in 1993 an extraordinarily high quantity of 1-ringers of the 1991 year class was caught in this area.

The revised IBTS index for the period 1979-1995 (year classes 1977-1993) is given in Table 2.3.1 and illustrated in Figure 2.3.2. The index value based on the 1995 IBTS survey (1993 year class) indicates a decline in recruitment to a level comparable to the poor year classes 1988-1990.

2.3.2 The MIK-index of recruitment

The 0-ringer index is based on night catches of larval herring with a modal length of more than 20 mm during the IBTS in February. The sampling gear is a fine-meshed ring-net (MIK). An index value is

determined in the following way: 1) mean densities per unit area are calculated within sampled rectangles, 2) the mean densities are averaged within 8 sections covering the survey area, 3) the densities for sections are multiplied by the area of each section and 4) the abundances within sections are summed to a total abundance estimate. The total abundance estimate divided by 10^9 is referred to as the 0-ringer index (see Table 2.3.2.).

The MIK-index based on the 1995 sampling (the 1994 year class) is estimated to be 126.9. This estimate indicates a slight increase in recruitment since last year, the estimate being close to the mean of the preceding year classes 1977-1993 (120.1). In Figure 2.3.2 the time series of MIK indices is illustrated.

In Figure 2.3.3 the spatial distribution of herring larvae with a modal length of more than 20 mm is illustrated for the year classes 1992-1994. The distribution pattern of the 1994 year class shows a concentration of larvae in the central/western parts of the North Sea.

2.3.3 Relationship between the MIK 0-ringer and the IBTS 1-ringer indices

Earlier interpretations of the relationship between the 0-ringer and the 1-ringer indices have shown that the year class estimates are well described by a linear relationship (e.g. Anon 1994a). The present 1-ringer estimate of the 1993 year class and last years 0-ringer estimate of the same year class are included in the series which is illustrated in Figure 2.3.4. The r-square of the relationship is 0.76. The two estimates of the 1993 year class agree well with the general relationship.

2.3.4 Recruitment prediction by the RCT3 regression program

The recruitment of the latest year classes is predicted in the VPA of the ICA program. At last year's meeting the recruitment was predicted by the combined regression method, RCT3. For comparative purposes a RCT3 prediction has been carried out following the methods used last year. The data used in the analysis are shown in Table 2.3.3. The two recruitment indices are weighted according to the procedures of the RCT3 in a prediction of the year classes 1992-1994 for the 0-ringers and the year classes 1991-1993 for the 1-ringers. The output of the RCT3 is shown in Tables 2.3.4 and 2.3.5 and the predictions are inserted in Table 2.3.3.

2.3.5 Trends in recruitment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn-spawners is illustrated in Figure 2.3.5. The year classes 1976 to 1990 are based

on the results from the VPA (using the ICA procedures) while the year classes 1991 to 1993 are the predictions from above. During the period we observe two sequences of an increase and subsequent decline, with peaks in the 1985 and 1991 year classes.

2.4 Acoustic Surveys

The ICES-coordinated acoustic survey in Divisions Iva and Ivb was carried out by vessels from Norway, Scotland, the Netherlands and Denmark. The following ships participated in the survey:

GO Sars	2-21 July
Tridens	20-28 June
Scotia	6-26 July
Dana	10-26 July

Results of the surveys were presented to the meeting in a working document (Simmonds *et al.*, 1995 WD). In addition to the surveys reported in this working document, Germany carried out an acoustic survey in the eastern central North Sea and Skagerrak from 12-25 July. For this cruise, only data on numbers and biomass of 1-ringed herring were available to the Working Group. Due to a failure in communication, a problem which has now been addressed, other information on this cruise has not been exchanged.

The surveys adequately covered the areas where adult herring were assumed to be distributed. Results were reported in numbers by age group for each statistical rectangle. Figures 2.4.1 and 2.4.2 show the distribution by rectangle of numbers and biomass.

The highest concentration of older herring was found northwest of Shetland. Smaller concentrations were encountered off Aberdeen and near Viking Bank. There was a remarkable scarcity of herring in the Norwegian zone north of 59°N. In the Skagerrak area, a concentration of predominantly juvenile herring was observed. Data were grouped into three different areas:

Division IVa west of 6°
 Division IVb west of 6°
 North Sea east of 6° and Skagerrak

Total numbers by age group were calculated for each of the areas. A distinction was made between North Sea autumn-spawners and Baltic spring-spawners on the basis of vertebrae counts. Age groups 2- and 3-ringers were split into a mature and immature component. All herring in maturity stage 3 or higher were classified as mature. The percentage of mature herring in age groups 2- and 3 in 1994 was considerably higher than in the previous year, and it was comparable with data for the years 1990-92 (see Section 2.6). The year 1993 appears to have been an outlier with respect to the maturation of herring.

Table 2.4.1 presents estimated numbers, biomass and mean weight of autumn-spawners by age, maturity and area. Mean weights for 0-ringers were not available and they are not included in the estimate of biomass. The total stock estimate of autumn-spawning herring in the North Sea was 1,368,000 t, of which 1,035,000 t consisted of mature fish. The time series of estimates from 1984-1994 is given in Table 2.4.2.

To make the spawning stock estimate from the acoustic survey comparable to the estimate from VPA, catches of mature herring taken between the average survey date (15 July) and the time of spawning should be deducted. In the VPA it is assumed that spawning takes place when 67% of the annual fishing mortality has been reached. According to Figure 2.11.13, the date when 67% of the annual catch had been taken was approximately 20 August.

The adult catch (2-ringers and older) taken in the 3rd quarter was 167,000 t. Out of this adult catch, 18% immature 2-ringers and 9% immature 3-ringers have to be removed. This leads to a catch of 152,000 t mature adults in the 3rd quarter of 1994. The catch of mature adults between 15 July and 20 August is estimated at 45% of the total catch taken in the 3rd quarter, which is 68,000 t. Deducting this amount from the acoustic estimate for July leaves a spawning stock estimate of 967,000 t.

2.5 Larvae Surveys

The report on the international larvae surveys for 1993/1994, not available for the 1994 Working Group meeting, was presented. Sampling intensity was reduced both in spatial extent and in the number of samples taken. This follows the trend of a progressive reduction in effort since 1986/1987. Sampling in the North Sea was about one-third of the historical levels, although in the west of Scotland area Division VIa (N) effort remained about the same as in recent years.

The spatial and temporal coverage for the calculation of a larval abundance index (LAI) for all the North Sea areas was poor. The index for all areas shows that the declining trend in recent years is continuing (Table 2.5.1). Sampling coverage for the calculation of a larval production estimate (LPE), although less demanding than for the LAI, was still less than the minimum recommended in most areas (Table 2.5.2). The LPE index also shows a marked decline for all areas other than the southern North Sea and west of Scotland (Table 2.5.3)

The traditional LAI and LPE measures of abundance were defined on the assumption that reasonably complete spatial and temporal coverage of the spawning areas would be achieved. Quite clearly this assumption was not met in the 1993/1994 surveys. As a consequence it is not possible to determine whether

the decline in the indices is due to a reduction in stock size or whether it is an artifact of the reduction in sampling intensity. Neither the LAI nor the LPE indices for 1993/1994 were used for assessment purposes by the Working Group.

The results of the 1994/1995 surveys consisted entirely of sampling by the Netherlands in Division IVb (16-30 Sept.; 1-15 Oct.) and in Divisions IVc /VIId (12-31 Dec.). The results of sampling by Germany in Orkney / Shetland and in Divisions IVc / VIId in January 1995 were not available to the Working Group. Sampling intensity was further substantially reduced both in spatial extent and in the number of samples taken and now stands at an historically low level (Table 2.5.4). Larvae surveys in the west of Scotland area (Division VIa (N)) have been discontinued. Due to the very limited survey coverage neither the LAI nor the LPE indices were calculated. Instead historical estimates of the abundance of larvae in each area / time period have been calculated (Table 2.5.5). It is clear that these values do not provide any evidence of an increase in stock size in these areas in recent years.

It was noted that, because of the continuing declining effort on the larvae surveys, the Working Group is having to abandon the use of an important estimator of spawning stock size. Historically the larvae surveys have proved very valuable and were the only indication of the extent of the recovery following the total ban on the North Sea fishery from 1977 to 1981. Loss of the larvae survey indices is particularly regrettable for Divisions IVc and VIId where, without the full coverage of a larvae survey, it is difficult to comment either qualitatively or quantitatively on the state of the stock. ACFM should note that the loss of the larvae survey data is reducing the precision of the stock size estimation at a time when the North Sea stocks are declining towards a minimum biologically acceptable level.

2.6 Mean Weights-at-Age and Maturity-at-Age

2.6.1 Mean weights at age in the catch and stock

The mean weights at age (weighted by the numbers caught) of fish in the catches in 1994 are presented by ICES division and by quarter in Table 2.6.1. Table 2.6.2 shows a comparison of the mean weights at age, 2-rings and older, over the years 1986 to 1994. In 1993 the mean weight of 3-ringers for the total North Sea was the lowest since 1988 (Anon, 1994a). The mean weight of that year class (4-ringers) in 1994 has increased in Division IVa and in Divisions IVc /VIId to well above the average over recent years, indicating a significant improvement in their growth rate in these areas. In Division IVb the mean weight of the 4-ringers is still the lowest since 1988. For the total North Sea the mean weight of this year class is just below the ten year mean. The mean weights for all

other year classes generally show some improvement over the previous year. For example the mean weights of 2-ringers have either increased or remained stable, for 3-ringers there is an increase in all areas and for 5-ringers only Division IVb shows a decrease. For the 6-, 7-, and 8-ringers the mean weights for the total North Sea all show an increase since 1993.

Table 2.6.3 presents the mean weights at age in the catch during the 3rd quarter in Divisions IVa and IVb for the years 1987 to 1994. In this quarter most fish are approaching their peak weights just prior to spawning. With the exception of the 2-ringers the mean weights all show an increase in 1994 compared with 1993. For comparison the mean weights in the stock from the last four years of summer acoustic surveys are shown in the same table (see Table 2.4.1 for 1994 values). The mean weights of the 2-ringers in this table include the autumn-spawning component from Division IIIa. In 1993 the mean weight of 2- and 3-ringers on this survey was down by 19% and 30% respectively (Anon 1994a). In 1994 the survey results indicate a significant recovery in the growth rate of all age groups with the exception of the 1-ringers. Compared with the previous year, the mean weight of 2-ringers is up by 17%, 3-ringers by 30%, 4-ringers by 8%, 5-ringers by 10% and the 6-, 7-, and 8-ringers by 4%, 9% and 6% respectively.

All the evidence suggests that there has been a significant improvement in the growth rate of all age groups in the North Sea during 1994. On an area basis the improvement in Division IVb is not so marked. As might be expected from the situation described in last year's report, the improvement in the growth rate of the 4-ringers is smaller than for other age groups.

2.6.2 Maturity Ogive

The percentage of 2- and 3-ringers likely to mature in 1994 was estimated from the summer acoustic survey. The percentages likely to have spawned in 1994 (maturity stages 3 and above during the survey) are given in the table below. The values for 1992 and 1993 have been corrected to include the autumn-spawning 2-ringers in the Skaggeak. The percent of 2-ringers mature for 1992 has surprisingly increased because the original value erroneously included Division VIa. The tabulated values prior to 1992 all included 2-ringers in the Skaggeak.

Age (winter rings)	2	3	Older
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	98.0	100
1992	51.3	100	100
1993	41.6	62.9	100
1994	72.1	85.8	100

The maturity of both 2- and 3-ringers in 1994 has increased significantly compared with 1993. For the 2-ringers the percentage mature is close to the high values recorded in 1989 and 1990. The change is probably a reflection of the improved growth rates observed in 1994 and reflected in increases in the mean weight at age in the stock for 2-ringers and older.

2.7 Status of the stocks

2.7.1 Total North Sea stock

Assessment of the stock was done by means of the ICA program. This program has the advantage of being able to utilise age-aggregated indices of stock size. In addition, the program assumes that errors occur not only in the survey indices, but also in the catch at age matrix. This is considered a more realistic approach than using the catches at age as absolute values. A full discussion of the ICA program was discussed in last year's report of this working group (Anon 1994a, Appendix 1).

During last year's meeting, some problems were still encountered with the ICA program. This concerned the difference between using the IBTS-survey as an age-disaggregated index, and using it as an index of spawning stock biomass. These problems were resolved in a working document to the ACFM meeting in November 1994 (Patterson 1995a).

Indices of spawning stock biomass available to the WG are presented in Table 2.7.1. The series of LPE indices was discontinued in 1993. However, the LPE-values for the years 1983 - 1992 could still be used in the present analysis. For the other surveys (IBTS and acoustic surveys), the age-disaggregated indices were used instead of the SSB indices. It is assumed that the age-disaggregated indices contain more information on stock structure (provided that age-sampling is adequate) than the SSB indices derived from these surveys. Details on input parameters for the ICA are given in Table 2.7.2.

The objective function fitted was:

$$\begin{aligned}
& \sum_{a=0, y=1992}^{a=8, y=1994} \lambda_a (\ln(\hat{C}_{a,y}) - \ln(C_{a,y}))^2 + \\
& \sum_{y=1982}^{y=1992} (\ln(QV \cdot \hat{SSB}_y) - \ln(LPE_y))^2 + \\
& \sum_{a=2, y=1985}^{a=5+, y=1995} (\ln(QI_a \cdot N_{a,y}^*) - \ln(IBTS_{a,y}))^2 + \\
& \sum_{l, 1979}^{l, 1995} (\ln(QL \cdot N_{l,y}^*) - \ln(IBTS_{l,y}))^2 + \\
& \sum_{a=2, y=1989}^{a=9+, y=1994} (\ln(QA_a \cdot N_{a,y}^*) - \ln(ACOUST_{a,y}))^2 + \\
& \sum_{a=0, y=1978}^{a=0, y=1995} (\ln(QM \cdot N_{0,y}^*) - \ln(MIK_y))^2 + \\
& \sum_{y=1958}^{y=1994} (\ln(N_{0,y+1}) - \ln\left(\frac{A \cdot SSB_y}{B + SSB_y}\right))^2
\end{aligned}$$

in which QV, QI, QR, QA and QM respectively represent the 'catchabilities' of the LPE index, the age-disaggregated 2 to 5+ IBTS survey, the IBTS 1-ringer index, the acoustic survey and the MIK index. Lambda is an arbitrary weighting factor set to 0.01 for age 0, 0.5 for age 1 and 1.0 for all other ages. Errors in the acoustic survey and the age-disaggregated IBTS survey are assumed to be correlated. N^* are population sizes calculated at the time of year corresponding to each of the surveys, and A and B are parameters of the Beverton and Holt stock-recruit relationship.

A linear relationship with VPA estimates was assumed for all survey indices. This seems to be the most reasonable assumption in the absence of strong evidence for other models. From trial runs with the separable VPA, it was clear that a change in selection pattern had taken place over the last 6 years, particularly in the younger age groups. To overcome this problem, the separable constraint for the SVPA was restricted to the last 3 years. In addition, the weight on the younger age-groups in the catch at age matrix was reduced.

A series of runs was made in which each of the indices was compared to the catch at age matrix. This exercise showed the goodness of fit and the distribution of residuals for each of the individual survey indices. The results for the acoustic survey index showed strong negative residuals in 1987-88 and in 1994. It was seen that these residuals were due to the relatively low acoustic estimates in years 1987-88 compared to the results of VPA. The acoustic surveys for the years 1987-88 have probably underestimated the stock size due to an abnormal distribution of the stock (Aglen and Simmonds 1988, Anon 1989a). A run with the acoustic surveys excluding the years 1987-88 gave results that were more consistent over the years, and with the results of the IBTS series:

index	mean	+SD	-SD
	F94		
IBTS 2-5 ringers	0.49	0.39	0.61
Acoustic survey 87-94	0.22	0.19	0.26
Acoustic survey 89-94	0.52	0.44	0.61

It was decided, therefore, to use the acoustic series for the years 1989-94 in the further analysis.

A run for all indices combined, using the iterative weighting function of ICA2, gave unrealistic results, in that the acoustic survey, and to a lesser extent the IBTS, were allocated excessive weighting in relation to the catch at age data. This was apparently caused by the insufficient length of the acoustic data series, which resulted in the model becoming unstable. It was decided, therefore, to replace the iterative weighting by manual weighting. In the absence of statistical information on the variance of each survey estimate, it was not possible to give certain surveys more weight than others in an objective fashion. Therefore, equal weights were applied to all surveys and all age groups.

The output of the ICA using the above input parameters is presented in Table 2.7.3 and Figures 2.7.1-2.7.18. The results of this analysis indicate a mean fishing mortality of 0.53 in 1994, and a spawning stock size of 792,000 t.

Terminal fishing mortalities estimated by ICA for 1994 were used to initiate a conventional VPA, the results of which are presented in Table 2.7.4.

Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.7.19.

2.7.2 Stock in Divisions Ivc and VIIId

The difference in age structure between the catches in Divisions IVC, VIIId and in the rest of the North Sea clearly indicates that the development of the southern

North Sea population is different from that in the rest of the North Sea. The relative abundance of older age groups in the catches in 1994 could indicate either a low mortality rate, or a low recruitment in recent years. Without additional information from surveys, it is not possible to judge which of these two explanations is the correct one.

Until recently, herring larvae surveys in the southern North Sea and eastern English Channel provided independent information on the development of the spawning stock in this area. However, sampling effort in these surveys has in recent years been reduced to a level where the results of the surveys can no longer be utilised for stock assessment. Therefore, the Working Group was unable to come to a conclusion as to the recent development of the spawning stock in this area.

2.8 Projection of Catch and Stock of North Sea Autumn-Spawners by Area and Fleet

The starting point for the projection is the stock of North Sea autumn-spawners in the North Sea and Division IIIa combined at 1 January 1995. For 2-ringers and older the ICA estimate is used (Table 2.7.3). The number of 0-ringers and 1-ringers at 1 January 1995 are the RCT3 estimates of 48,800 million 0-ringers and 11,700 million 1-ringers as described in Section 2.3. 0-ringers at 1 January 1996 are set at 44,084 million.

Mean weights at age in the stock were taken as the average over the last four years, and maturity at age, natural mortality and proportions of F and M before spawning are all taken from the ICA input for the year 1994 (Table 2.7.2). The fishing pattern for the total stock is taken from the separable ICA for 2-ringers and older (Table 2.7.3). For 0- and 1-ringers the fishing mortalities by fleet are calculated from catch and stock numbers in 1994 as shown in Table 2.8.1. The reference fishing mortalities for 2-ringers and older fish by age, fleet and area were calculated by combining the exploitation patterns, the 1994 fishing level and the distribution of the catch in numbers by fleet.

Catch predictions for 1995 and 1996 were made for the same five fleets as in last year's assessment:

- A) Human consumption fisheries in the North Sea. A minor part of the catches taken in this fishery may be landed for industrial purposes;
- B) Small-mesh fisheries in the North Sea. Landings used for industrial purposes;
- C) Human consumption landings in Division IIIa. A part of the catches taken in this fishery may be landed for industrial purposes;

D) Mixed clupeoid landings in Division IIIa. Some landings taken under the "mixed clupeoid quota" may be included in the catches taken by fleet E;

E) Other industrial landings in Division IIIa.

Mean weights at age in the 1994 catches by fleet were applied for the predictions.

To get as realistic a projection as possible, the calculations were carried out by fleet and area. The proportion of 0- and 1-ringers that occur in Division IIIa is likely to vary between years depending on the size of the year class. For the 1-ringers this is reflected in the IBTS results presented in Table 2.8.1 in last year's report (Anon. 1994a).

The 2-ringers migrate from Division IIIa to the North Sea during the year and very few 3-ringers and older are found in Division IIIa. Total mixing of 2-ringers in Division IIIa and the North Sea was assumed. Therefore, the stock numbers of 2-ringers given in Table 2.8.1 are the same for Division IIIa and the North Sea. 3-ringers and older were assumed to be exclusively in the North Sea.

The abundance of 0- and 1-ringers in Division IIIa were estimated using the procedure suggested by the Workshop on Methods of Forecasting Herring Catches in Division IIIa (Anon., 1992d). The proportion of 1-ringers in Division IIIa estimated during the IBTS is regressed against the MIK index with a time lag of 1 year. The result of the regression is given in Table 2.8.1 in last year's report (Anon. 1994a). The 1995 MIK index was used to predict the proportion of 1-ringers in 1996. This proportion was used to separate the 0-ringers in 1995 by area. The IBTS 1-ringer catches in 1995 was used to separate the 1-ringers in 1995 between the North Sea and Division IIIa. The proportion of 0-ringers by area in 1996 is based on a hypothetical MIK index value which corresponds to the mean 0-ringer abundance in 1947-1994.

The input data for the projection are given in Table 2.8.2.

Projections were made, based on *status quo* fishing mortalities ($F_{1995}=F_{1994}$). A summary of the projections are given in Table 2.8.3.

The catches in 1995 are estimated assuming unchanged fishing mortality (i.e. F by area) in all five fleets from 1994 to 1995, giving a total catch in 1995 of 546,000 t and a SSB of 718,000 t. As seen in Table 2.8.3 the catches in Division IIIa are predicted to be 73,000 t. The Working Group considered this figure to be low but explained this by the lower recruitment, hence lower yield, in the small-meshed and mixed clupeoid fisheries.

The catches in 1996 by different combinations of fishing mortality by fleet under the assumptions of catches as outlined above for 1996 are shown in Tables 2.8.3 and 2.8.4. The catches taken in Division IIIa will have very little effect on the catches in the North Sea the same year, as the model used assumes no migration between areas for 0- and 1-ringers and the proportion of 2-ringers taken in Division IIIa is relatively small. For that reason the predictions are given independently for the North Sea and the Division IIIa fleets. The prediction shows that to maintain an SSB of 800,000 t in 1996 the F should be nearly halved compared to that of 1994. The prediction also shows that a reduction in exploitation of herring by Fleet B has little or no effect on SSB in the short term, but significant effect in the medium term (see Section 2.9.4).

2.9 Risk Analysis and Medium-Term Projections

2.9.1 Method used

The medium-term projections and risk analysis are calculated on the basis of the fitted populations and parameters estimated in the manner described in Section 2.7.1. A variance-covariance matrix for the fitted parameters (logarithms of population sizes, fishing mortalities at reference ages by year, selection at age, estimated recruitment in 1995, catchabilities for each index and parameters of the stock-recruit relationship) was also estimated. A baseline projection was calculated in the conventional way, and the delta method (linear combination of covariances) was used to estimate the variance in the projected population. Errors in the projected stock size were assumed to be lognormally distributed, and a probability profile constructed on that assumption. The method is the same as that used by Patterson (WD, 1995) and in Anon (1995). In future exercises of this type it is proposed to use a model of serially-correlated errors about the stock-recruit relationship, as described in Section 1.7.

Natural mortality, stock weights at age in the catches and in the stock, and maturity ogives were assumed fixed at their mean values from 1990 to 1994.

It is stressed that risk profiles calculated using this method are rather conservative, in that it is assumed that the data conform to the assumptions of the model. Alternative assumptions made in formulating the assessment model could lead to widely different perceptions of stock size.

2.9.2 Risk in the Short Term

It is presumed that the management action under immediate consideration is the setting of a catch level for the human consumption fishery in the North Sea in 1996. A calculation is made here of the probability that

the spawning stock biomass will be lower than the MBAL level of 800 000t at spawning time in 1996, for a range of catch options for the North Sea human consumption catch in 1996. The following have been assumed:

- Catch by each fleet in 1995 = Mean catch by each fleet in 1992-1994
- Catch by fleet B and catch in IIIa in 1995 and 1996 = Mean catch by each fleet from 1992-1994
- A range of catch options by fleet A for 1996 is considered.

Results are shown in Figure 2.9.1.

2.9.3 Multiannual Catch Options

The risk of the spawning stock falling below the MBAL value in three of the many possible catch options was evaluated. Firstly,

- I: Catch in all fleets remaining at their historic mean levels from 1992-1994 in the years 1995-1997;
- II: A reduction in the catch by the North Sea human consumption fleet (A) of 20% from the historic mean level in 1996 and 1997.

Results of these calculations are given in Figure 2.9.2. In either case the stock is predicted to remain below MBAL in all three years of the projections. A further calculation was made assuming a reduction in the human consumption catch to 250 000t in 1996 and 1997. Results of this third analysis are given in Figure 2.9.3. Under this assumption, the stock is predicted to have an approximately 50% chance of being above MBAL in 1995 and an 80% chance of being above MBAL in 1997.

2.9.4 Projections for the Medium Term

A series of projections was calculated in order to show the impact of the small-meshed fishery in the North Sea (Fleet B) on both the spawning stock size and the yield to the human consumption fishery under conditions of exploitation at constant fishing mortality. The following baseline conditions were chosen and held constant in all the simulations:

1. Starting populations, selection pattern, fishing mortality and parameters of the stock-recruit relationship were chosen and held constant in all the simulations;
2. Uncertainty about the assessment and projections was calculated using the delta method and based on the variance-covariance matrix calculated by the ICA programmes;

3. Natural mortality, maturity ogives and weights at age in the stock were assumed fixed at the values of the historical means from 1990 to 1994;
4. Weights at age in the catches by fleet were also assumed known precisely and were assumed to take the values given in Table 2.8.2;
5. The partitioning of fishing mortalities across fleets was also assumed to be known precisely. Values are taken from Table 2.8.2;
6. Fishing mortality in 1995 was constrained to be equal to the estimated fishing mortality in 1994 for all fleets;
7. For the years 1995 to 2004, fishing mortality was constrained equal to the estimated fishing mortality in 1994 for all fleets except for Fleet B.

Four medium-term projections were calculated for different levels of fishing mortality exerted by this fleet. The four levels were calculated on the basis of the projection calculated without uncertainty, such that the expected catch by Fleet B would be zero, 50,000 t, 100,000 t or 150,000 t.

Results of the four simulations are given in Figure 2.9.4 (a-d). For convenience the results are also summarised in the text table below:

Catch Options for the Small-Mesh Fishery in the North Sea.

Annual catch by Fleet B ('000 t)	Catch by Fleet A at constant F (=F) 1994) from 1996 to 2004 ('000 t)	Spawning stock in 2004 ('000 t)
Nil	4,920	1,060
50	4,190	816
100	3,450	560
150	2,680	281

The prediction shows that compared to the level of exploitation in Fleet B in recent years (100-150,000 t) a significant gain in both yield and SSB may be achieved.

2.10 Management Considerations

Area TACS

The Working Group has become aware that in several parts of the North Sea large scale misreporting of catches to adjacent areas may occur. Examples of this are:

- catches in Shetland area reported as coming from Division VIa(N)

- catches from eastern central North Sea reported as coming from Division IIIa
- catches from Divisions IVc, VIId reported as coming from Division IVb

The misreporting of catches causes severe problems in the assessment, not only of the North Sea stock, but also for the stocks in the adjacent areas. Apart from the problems in stock assessment, the misreporting of catches will also create problems in management. If catches taken from a certain stock are not counted against the TAC set for that stock, the usefulness of area TACs becomes questionable. Managers should therefore either try to reduce the problem of misreporting or else merge adjacent management areas from which catches cannot be separated.

Management risks

In addition to the statistical risks of various management options presented in Section 2.9.2, the Working Group would like to point out that additional risks will exist due to uncertainties in the present assessment. There are a number of indications that the current assessment for the North Sea stock may still be too optimistic, and that the assessment will have to be revised downward in future.

Stock estimates presented by the Working Group for the spawning stock prior to 1993 have now been revised downward for three years in succession. This may indicate that the Working Group has a systematic bias towards overestimating stock size.

The current assessment estimates a reduction in F on adult herring in 1994. There is no explanation for such a reduction. If this apparent reduction in F in 1994 is due to errors in the assessment, the stock in 1995 is overestimated.

The Working Group stresses that a situation of a declining stock size and increasing exploitation of younger fish poses a severe threat to the stock and the fishery.

By-catches of juvenile herring in small-meshed fisheries

Catch figures for 1994 showed a marked decline of by-catches of juvenile herring in the small-mesh fishery for sprat. The Working Group was unable to decide whether this reduction in by-catches was due to increased enforcement of the existing by-catch regulation. Obviously, the increased abundance of sprat in the North Sea must have alleviated the problems of avoiding herring by-catches in the sprat fishery. It is not clear whether fishing mortality for juvenile herring will remain at the 1994 level if the sprat population declines again. The Working Group refers to the calculations presented in last year's report

(Anon. 1994a) about the impact of catches of juvenile herring on the directed fisheries and the development of spawning stock biomass. These calculations were based on relatively high assumptions of M in juvenile herring; if these values were to be reduced on the basis of the new MSVPA, the effect of the by-catch of juvenile herring would increase.

2.11 Requests from the Multispecies Assessment Working Group

The Multispecies Assessment Working Group requests data on quarterly catches and mean weights at age in the catch and stocks for 1994, by statistical rectangle of the North Sea for herring. Data at this level of detail are not available, and the Working Group has decided to provide for 1994 the same format as in previous years.

2.11.1 Quarterly database (numbers and mean weights at age)

Quarterly catch-at-age data, together with quarterly weights at age in the catch and in the stock at spawning time for North Sea herring for 1994 are provided in Table 2.11.1.

Weight-at-age data for the stock at spawning time are best provided by samples taken during the July acoustic surveys which cover Divisions IVa and IVb, and these are shown in the bottom line of Table 2.11.1.

A comparable breakdown of catches of spring-spawners taken in the North Sea and transferred to Division IIIa is shown in Table 2.2.3.

2.11.2 Geographical distribution of the catches in the North Sea in 1993

Data on the geographical distribution of catches in the North Sea (Sub-area IV and Division VIId) in 1994 were available from Denmark, the Netherlands, Norway, Sweden, the UK (Scotland England) and 80% of French catches. The data represent 94% of the total catch, and include both juveniles and adults. Figures 2.11.1-2.11.1.2 show the catch by ICES rectangle for each month. The total catch by month was available from all countries.

Therefore, the cumulative catch by month for the total North Sea, shown in Figure 2.11.13, includes all the catches in the North Sea.

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIIId). Catch in tonnes by country, 1983-1994. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1983	1984	1985	1986	1987	1988
Belgium	5,969	5,080	3,482	414	39	4
Denmark	10,467	38,777	129,305	121,631	138,596	263,006
Faroe Islands	-	-	-	623	2,228	810
France	16,353	20,320	14,400	9,729	7,266	8,384
Germany, Fed.Rep.	1,837	11,609	8,930	3,934	5,552	13,824
Netherlands	40,045	44,308	79,335	85,998	91,478	82,267
Norway ⁴	32,512	98,706	159,947	223,058	241,765	222,719
Sweden	284	886	2,442	1,872	1,725	1,819
UK (England)	111	1,689	5,564	1,404	873	8,097
UK (Scotland)	17,260	31,393	55,795	77,459	76,413	64,108
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	181,116	64,487	74,220	21,089	58,972	33,411
Total landings	305,954	317,255	533,420	547,211	624,907	698,449
Discards ³	-	-	-	-	-	-
Total catch	305,954	317,255	533,420	547,211	624,907	698,449
Catches of spring spawners (included above)						
IIIa type	-	-	6,958	17,386	19,654	23,306
Coastal type	-	-	520	905	490	250

Country	1989	1990-	1991	1992	1993	1994 ¹
Belgium	434	180	163	242	56	144
Denmark	210,315 ²	159,280 ²	194,358 ²	193,968 ²	164,817	121,559
Faroe Islands	1,916	633	334	-	-	-
France	29,085	23,480	24,625	16,587	12,627	27,941
Germany, Fed.Rep.	38,707	43,191	41,791	42,665	41,669	38,394
Netherlands	84,178	69,828	75,135	75,683	79,190	76,155
Norway ⁴	221,891 ²	157,850 ²	124,991 ²	116,863	122,815	125,522
Sweden	4,774	3,754	5,866	4,939	5,782	5,425
UK (England)	7,980	8,333	11,548	11,314	19,853	14,216
UK (Scotland)	68,106	56,812	57,572	56,171	55,531	49,919
UK (N.Ireland)	-	-	92	-	-	-
Unallocated landings	26,749 ²	21,081	24,435	25,867	18,410	5,749
Total landings	694,135 ²	544,422	560,910	544,299	520,550	465,024
Discards ³	4,000	8,660	4,617	4,950	3,470	2,510
Total catch	698,135	553,082	565,527	549,249	524,020	467,534
Catches of spring spawners (included above)						
IIIa type	19,869	8,357	7,894	7,854	8,928	13,228
Coastal type	2,283	1,136	252 ⁵	202 ⁵	201 ⁵	215 ⁵

¹Preliminary.

²Working Group estimates.

³Any discards prior to 1989 were included in unallocated landings.

⁴Catches of Norwegian spring spawners removed (taken under a separate TAC).

⁵Landings from the Thames estuary area.

Table 2.1.2 HERRING, catch in tonnes in Division IVa West. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes

Country	1985	1986	1987	1988	1989
Denmark	77,788	48,590	50,184	25,268	29,298
Faroe Islands	-	275	102	810	1,916
France	2,075	462	285	266	- ¹
Germany, Fed.Rep.	4,790	2,510	3,250	9,308	26,528
Netherlands	49,965	42,900	44,358	32,639	24,600
Norway	10,507	63,848	55,311	30,657	41,768
Sweden	-	- ¹	768	1,197	742
UK (N.Ireland)	1	-	-	-	-
UK (England)	-	-	4,820	4,820	5,104
UK (Scotland)	-	71,285	66,774	48,791	58,455
Unallocated landings	52,100	-	16,092	-	3,173
Total Landings	4,249	229,870	221,032	153,751	191,584
	197,225				
Discards ²	-	-	-	-	900
Total catch	201,474	229,870	237,124	153,751	192,484

Country	1990	1991	1992	1993 ³	1994
Denmark	9,037	5,980	10,751	10,604	20,017
Faroe Islands	633	334	-	-	-
France	2,581	3,393	4,714 ⁴	3,362	11,658
Germany, Fed.Rep.	20,422	20,608	21,836	17,342 ⁴	18,364
Netherlands	29,729	29,563	29,845	28,616	16,944
Norway	24,239	37,674	39,244	33,442	56,422
Sweden	-	1,130	985	1,372	2,159
UK (N.Ireland)	-	92	-	-	-
UK (England)	3,337	4,873	4,916	4,742	3,862
UK (Scotland)	46,431	42,745	39,269	36,628 ⁴	44,687
Unallocated landings	4,621	5,492	4,855	-8,271 ⁵	2,944
Total Landings	141,030	151,884	156,415	127,837	177,327
Discards ²	750	883	850	825	550
Total catch	141,780	152,767	157,265	128,662	177,877

¹Included in Division IVb.

²Any discards prior to 1989 were included in unallocated.

³Preliminary.

⁴Including IVa East.

⁵Negative unallocated catches due to misreporting from other areas.

Table 2.1.3

HERRING, catch in tonnes in Division IVa East. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1984	1985	1986	1987	1988
Denmark	126	-	4,540	7,101	47,183
Faroe Islands	-	-	-	2,126	-
France	-	-	-	159	45
Netherlands	-	-	-	-	200
Norway ¹	51,581	109,975	118,408	145,843	153,496
Sweden	-	-	-	957	622
UK (Scotland)	74	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Unallocated landings	-	-	-	-	-
Total landings	51,781	109,975	122,348	156,186	201,546
Discards ²	-	-	-	-	-
Total catch	51,781	109,975	122,948	156,186	201,546

Country	1989	1990	1991	1992 ³	1993	1994
Denmark	44,269	44,364	48,875	53,692	43,224	43,767
Faroe Islands	-	-	-	-	-	-
France	-	892	-	- ⁴	4	14
Netherlands	-	-	-	-	-	-
Norway ¹	168,365	121,405	77,465	61,379	56,215	40,658
Sweden	612	2,482	114	508	711	1,010
UK (Scotland)	-	-	173	196	- ⁴	-
Germany, Fed.Rep.	-	5,604	- ⁴	- ⁴	- ⁴	-
Unallocated landings	-	-	-	-	-	-
Total landings	213,246	174,747	126,627	115,775	100,154	85,469
Discards ²	-	-	-	-	-	-
Total catch	213,246	174,747	126,627	115,775	100,154	85,469

¹Catches of Norwegian spring spawners herring removed (taken under a separate TAC).

²Any discards prior to 1989 would have been included in unallocated.

³Preliminary.

⁴Included in IVa West.

Table 2.1.4 HERRING, catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989
Denmark	51,517	67,966	81,280	190,555	136,239
Belgium	-	-	-	-	-
France	1,037	605	387	617	14,415 ⁵
Faroe Islands	-	348	-	-	-
Germany, Fed.Rep.	4,139	1,424	2,302	4,516	11,880
Netherlands ⁴	- ³	21,101	31,371	37,192	47,388
Norway	39,465	40,682	40,111	38,566	11,758
Sweden	2,442 ²	1,872 ²	-	-	3,420
UK (England)	5,214	1,101 ¹	329	2,011	957
UK (Scotland)	2,894	6,057	9,639	15,317	9,651
Unallocated landings	47,799	1,594	20,829	1,969	-23,947 ⁷
Total landings	154,507	142,750	186,248	290,743	211,711
Discards ⁴	-	-	-	-	1,900
Total catch	154,507	142,750	186,248	290,743	213,611

Country	1990	1991	1992	1993	1994 ⁶
Denmark	105,614	138,555	125,229	109,994	55,060
Belgium	-	3	13	-	-
France	10,289	4,120	2,313	2,086	5,492
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	17,165	20,479	20,005	23,628	14,796
Netherlands ⁴	28,402	26,266	26,987	31,370	39,052
Norway	12,207	9,852	16,240	33,158	28,442
Sweden	1,276	4,622	3,446	3,699	2,256
UK (England)	3,200	2,715	3,026	3,804	7,337
UK (Scotland)	10,381	14,587	16,707	18,904	5,101
Unallocated landings	-15,616 ⁷	3,180	-13,637 ⁷	-16,415 ⁷	-26,988 ⁷
Total landings	172,914	224,376	200,329	210,228	130,548
Discards ⁴	2,560	1,072	1,900	245	460-
Total catch	175,474	225,448	202,229	210,473	131,008

¹Includes catches misreported from Division IVc.

²Includes Division IVa catches.

³Included in Division IVa.

⁴Any discards prior to 1989 were included in unallocated.

⁵Includes catch in Division IVa.

⁶Preliminary.

⁷Negative unallocated catches due to misreporting from other areas.

Table 2.1.5 HERRING, catch in tonnes in Divisions IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989
Belgium	3,482	414	39	4	434
Denmark	-	535	31	-	509
France	11,288	8,662	6,435	7,456	14,670
Germany, Fed.Rep.	-	-	-	-	299
Netherlands	32,370	21,997	15,749	12,236	12,240
Norway	-	-	-	-	-
UK (England)	350	303	544	1,266	1,919
UK (Scotland)	799	117	-	-	-
Unallocated landings	21,595	19,495	22,051	31,442	47,523
Total landings	69,884	51,523	44,849	52,404	77,594
Discards ¹	-	-	-	-	1,200
Total catch	69,884	51,523	44,849	52,404	78,794
Coastal spring spawners included above	905	496	250	250	2,283

Country	1990	1991	1992	1993	1994 ²
Belgium	180	163	229	56	144
Denmark	265	948	4,296	995	2,695
France	9,718	17,112	9,560	7,171	10,777
Germany, Fed.Rep.	-	704	824	649	4,964
Netherlands	11,697	19,306	18,851	19,204	20,159
Norway	-	-	-	-	-
UK (England)	1,796	3,960	3,372	11,307	3,016
UK (Scotland)	-	67	-	-	131
Unallocated landings	32,076	15,763	34,649	43,096	29,792
Total landings	55,732	58,023	71,781	82,478	71,678
Discards ¹	5,350	2,662	2,200	2,400	2,400
Total catch	61,082	60,685	73,981	84,878	74,078
Coastal spring spawners included above	1,136	252	202	201	215

¹Any discards prior to 1989 would have been included in unallocated.

²Preliminary.

Table 2.2.1 North Sea Herring, Millions caught by age group (winter ring), year class, division and quarter.

Catches in : 1994

Division	Quarter	0 1993	1 1992	2 1991	3 1990	4 1989	5 1988	6 1987	7 1986	8 1985	9 1984	Total	0+1 ring
IVa West of 2°E	I	0.0	0.0	1.7	2.6	1.3	3.5	4.1	8.2	6.9	3.8	32.1	0.0
	II	0.0	0.2	306.0	66.4	24.9	10.7	7.1	6.0	3.8	0.8	425.8	0.2
	III	0.0	0.4	205.9	56.5	32.2	21.0	21.9	27.2	33.8	22.3	421.4	0.4
	IV	0.1	5.8	81.2	22.0	4.5	7.0	6.4	4.0	3.3	2.3	136.7	5.9
	Total	0.1	6.5	594.8	147.4	63.0	42.2	39.5	45.4	47.8	29.2	1015.9	6.6
IVa East of 2° E	I	0.0	0.5	135.8	18.9	5.0	1.5	2.3	2.7	0.2	0.1	167.1	0.5
	II	0.0	0.0	55.4	20.3	7.9	12.0	6.6	4.4	4.8	1.1	112.3	0.0
	III	0.0	17.8	50.9	28.2	13.8	7.0	6.4	1.9	1.5	0.3	127.9	17.8
	IV	0.0	0.0	62.9	27.7	10.7	8.6	18.2	11.0	7.3	5.3	151.7	0.0
	Total	0.0	18.2	305.0	95.1	37.4	29.1	33.5	20.1	13.8	6.8	559.0	18.2
IVb	I	0.0	96.1	2.4	1.2	1.3	0.3	0.0	0.0	0.0	0.0	101.4	96.1
	II	91.5	56.4	91.9	26.0	9.3	1.7	0.3	0.2	0.0	0.0	277.3	147.9
	III	3041.3	208.8	260.8	100.6	37.9	21.4	8.4	2.9	1.0	1.7	3685.0	3250.1
	IV	573.3	49.9	23.9	9.5	8.7	2.8	2.0	0.8	0.2	0.4	671.5	623.2
	Total	3706.1	411.2	379.0	137.3	57.2	26.2	10.8	3.9	1.2	2.2	4735.2	4117.4
IVc + VIId	I	0.0	1.0	4.0	20.0	46.1	3.8	2.9	0.8	2.0	2.7	83.2	1.0
	II	0.0	0.0	0.0	3.7	5.2	0.9	1.0	0.6	0.3	0.1	11.9	0.0
	III	0.0	0.0	2.7	2.9	2.3	0.3	0.3	0.0	0.0	0.0	8.6	0.0
	IV	11.1	13.5	106.4	84.7	134.2	11.6	7.5	4.9	4.3	3.8	382.1	24.6
	Total	11.1	14.5	113.1	111.4	187.8	16.7	11.7	6.3	6.6	6.6	485.9	25.6
Total North Sea	I	0.0	97.6	143.8	42.7	53.7	9.1	9.4	11.8	9.1	6.6	383.8	97.6
	II	91.5	56.6	453.3	116.3	47.3	25.3	14.9	11.2	8.9	2.0	827.4	148.1
	III	3041.3	227.0	520.4	188.3	86.2	49.8	37.1	32.0	36.4	24.4	4242.9	3268.3
	IV	584.5	69.3	274.4	144.0	158.2	30.0	34.1	20.6	15.1	11.8	1342.0	653.7
	Total	3717.3	450.5	1391.9	491.3	345.4	114.2	95.5	75.7	69.5	44.8	6796.1	4167.8

Table 2.2.2 Numbers (millions) of herring caught per age group (winter rings) in the North Sea ,1970-1994.

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	9+	
1970	898.1	1196.2	2002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5249.3
1971	684.0	4378.5	1146.8	662.5	208.3	26.9	30.5	26.8		12.4	7176.7
1972	750.4	3340.6	1440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6045.5
1973	289.4	2368.0	1344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4906.6
1974	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3189.3
1975	263.8	2460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3753.3
1976	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1482.0
1977	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7	+	656.3
1978	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	791.7	161.2	108.1	91.8	32.1	21.8	2.3	1.4	0.4	0.2	1211.0
1981	7888.7	447.0	264.3	56.9	39.5	28.5	22.7	18.7	5.5	1.1	8772.9
1982	9556.7	840.4	268.4	230.1	33.7	14.4	6.8	7.8	3.6	1.1	10963.0
1983	10029.9	1146.6	544.8	216.4	105.1	26.2	22.8	12.8	11.4	12.2	12128.2
1984	2189.4	561.1	986.5	417.1	189.9	77.8	21.7	24.2	10.6	17.8	4496.1
1985	1292.9	1620.2	1223.2	1187.6	367.6	124.1	43.5	20.0	13.2	15.9	5908.2
1986	704.0	1763.2	1155.1	827.1	458.3	127.7	61.1	20.2	13.4	14.6	5144.7
1987	1797.5	3522.4	2005.4	687.2	481.1	248.9	75.7	23.9	7.9	8.1	8858.1
1988	1292.9	1970.8	1955.5	1185.1	398.1	260.6	128.6	37.9	15.1	8.4	7253.0
1989	1955.8	1899.5	927.7	1383.6	828.1	218.3	129.4	63.3	20.7	8.7	7435.1
1990	853.9	1477.4	592.8	763.3	849.1	375.9	80.1	54.4	28.4	11.8	5087.1
1991	1594.2	1244.4	771.2	553.1	548.5	493.5	201.4	38.8	25.0	12.6	5482.7
1992	7598.2	643.4	960.9	411.8	334.6	341.5	360.1	144.7	37.7	23.2	10856.1
1993	6981.7	1283.9	760.4	597.7	306.7	216.2	223.7	185.9	85.8	41.2	10683.2
1994	3717.3	450.5	1391.9	491.3	345.4	114.2	95.5	75.7	69.5	44.8	6796.1

Table 2.2.3 Catches(numbers in millions) of IIIa spring spawners taken in the North Sea, and transfered to assesement of IIIa spring spawning stock. (1987-1994)

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	9+	
1987			35.5	35.0	25.0	8.9	2.8	0.7	0.1	0.1	108.1
1988			44.6	108.9	19.5	8.2	2.2	0.4			183.8
1989			27.3	52.7	38.3	11.6	8.7	3.8	1.7	0.2	144.3
1990			12.4	14.7	21.8	3.6	3.0	2.1	0.7	0.4	58.7
1991			6.7	15.1	18.0	9.1	3.1	0.8	0.3		53.0
1992			0.3	9.9	11.1	8.4	8.6	2.5	0.7	0.6	42.1
1993			4.2	10.8	12.3	8.4	5.9	4.7	1.7	1.0	49.0
1994			8.8	28.2	16.3	11.0	8.6	3.4	3.2	0.7	80.2

Table 2.2.4 Catches(numbers in millions) of North Sea autumn spawners taken in IIIa, and transfered to assesement of North Sea autumn spawners.

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	9+	
1987	6238.0	3153.0	117.0								9508.0
1998	1830.0	5792.0	292.0								7914.0
1989	1028.2	1170.5	654.8								2853.5
1990	397.9	1424.3	283.7								2105.9
1991	712.3	822.7	330.2								1865.2
1992	2407.5	1587.1	283.8	26.8	26.6	16.0	12.3	5.5	1.0		4366.6
1993	2910.7	2403.8	377.5								5691.9
1994	542.2	1239.7	305.2								2087.1

Table 2.2.5 Total catch (numbers in millions) per age of North Sea autumn spawning stock used for assessment

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	9+	
1987	8035.5	6675.4	2086.9	652.2	456.1	240.0	72.9	23.2	7.8	8.0	18258.0
1988	3122.9	7762.8	2202.9	1076.2	378.6	252.4	126.4	37.5	15.1	8.4	14983.2
1989	2984.0	3070.0	1555.2	1330.9	789.8	206.7	120.7	59.5	19.0	8.5	10144.3
1990	1251.8	2901.7	864.1	748.6	827.3	372.3	77.1	52.3	27.7	11.4	7134.3
1991	2306.5	2067.1	1094.8	538.0	530.5	484.4	198.4	38.0	24.7	12.6	7294.9
1992	10005.7	2230.5	1244.4	428.7	350.1	349.1	363.8	147.6	38.0	22.6	15180.6
1993	9892.4	3687.7	1133.6	586.9	294.4	207.8	217.8	181.2	84.1	40.2	16326.1
1994	4259.5	1690.2	1688.3	463.1	329.1	103.2	86.9	72.3	66.3	44.1	8803.0

Table 2.2.6 Percentage age composition of North Sea HERRING
(2-ringers and older) in the catch.
Catches in : 1994

Division	age in W.Rings Quarter	2 1991	3 1990	Older >= 1989	Total (millions)
IVa West	I	5.2	8.0	86.8	32.0
	II	71.9	15.6	12.5	425.6
	III	48.9	13.4	37.7	420.9
	IV	62.1	16.8	21.1	130.8
	Total	58.9	14.6	26.5	1009.4
IV a East	I	81.5	11.4	7.2	166.6
	II	49.3	18.0	32.6	112.3
	III	46.2	25.6	28.1	110.1
	IV	41.5	18.3	40.3	151.7
	Total	56.4	17.6	26.0	540.8
IVb	I	45.7	22.5	31.8	5.3
	II	71.0	20.1	8.9	129.4
	III	60.0	23.1	16.9	434.9
	IV	49.5	19.7	30.8	48.2
	Total	61.3	22.2	16.4	617.9
IVc + VIId	I	4.8	24.3	70.8	82.3
	II	0.1	31.2	68.7	11.9
	III	31.6	34.0	34.4	8.6
	IV	29.8	23.7	46.5	357.5
	Total	24.6	24.2	51.2	460.2
IVa + IVb	I	68.6	11.1	20.3	204.0
	II	67.9	16.9	15.2	667.3
	III	53.6	19.2	27.2	965.9
	IV	50.8	17.9	31.3	330.8
	Total	59.0	17.5	23.5	2168.0
Total North Sea	I	50.2	14.9	34.8	286.3
	II	66.7	17.1	16.1	679.2
	III	53.4	19.3	27.3	974.6
	IV	39.9	20.9	39.2	688.2
	Total	53.0	18.7	28.3	2628.3

Table 2.2.7 Catches (SOP,tons) of North Sea Herring, by quarter and division.
Catches in : 1994

		0	1	2	3	4	5	6	7	8	9 ↑	SOP
Quarter	Division	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	Total
I	IVaW	0	1	121	392	221	685	908	1833	1616	897	6674
	IVaE	0	27	13301	2243	777	268	426	474	41	19	17576
	IVb	0	1403	183	182	216	53	9	8	0	0	2054
	IVc	0	17	328	2022	5255	547	419	127	329	452	9495
Total		0	1448	13933	4839	6469	1553	1763	2441	1986	1368	35800
II	IVaW	0	16	38517	10312	4255	2205	1534	1301	860	208	59208
	IVaE	0	0	7260	3220	1432	2393	1400	999	1168	272	18144
	IVb	183	2181	10459	3508	1549	290	73	48	3	0	18294
	IVc	0	0	1	374	612	148	183	112	61	25	1514
Total		183	2196	56237	17414	7847	5036	3190	2461	2092	505	97160
III	IVaW	0	35	32719	11897	7519	5533	5734	7848	10120	6987	88392
	IVaE	0	1213	6439	3848	2269	1211	1403	431	353	89	17257
	IVb	14902	14992	31908	15248	6667	4385	1980	740	261	426	91511
	IVc	0	1	347	517	454	80	81	2	0	0	1482
Total		14902	16241	71414	31512	16908	11209	9198	9020	10735	7502	198641
IV	IVaW	1	433	12055	3885	1034	1514	1691	1066	879	653	23212
	IVaE	0	0	10646	5703	2657	2121	4833	2959	2065	1508	32492
	IVb	7542	3514	3771	1688	1690	640	492	188	50	106	19681
	IVc	143	1304	12597	13271	25924	2413	1758	1162	1129	961	60662
Total		7686	5251	39069	24546	31305	6688	8773	5375	4123	3229	136047
Total N. Sea	1994	22771	25136	180652	78310	62529	24486	22924	19298	18936	12604	467648

Table 2.2.8 North Sea Autumn Spawning Herring
Landings of Herring from the North Sea and Div. IIIa in 1994.
Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: HC in the North Sea B: Small meshed fishery in the North Sea C: Human consumption in Div IIIa
D: Mixed clupeoid fleet in Div IIIa E: Industrial fishery (for reduction) in Div IIIa

1. Quarter												
W. rings	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1	0.17	72.3	97.43	14.9	14.92	24.0	222.67	16.9	135.43	18.0	470.62	17.1
2	138.65	98.0	5.15	70.4	38.95	59.5	42.73	49.8	56.99	56.2	282.47	76.5
3	41.73	112.5	0.97	132.5							42.70	113.0
4	53.20	119.5	0.50	171.1							53.70	120.0
5	9.04	169.8	0.06	196.0							9.10	170.0
6	9.33	187.7	0.07	221.8							9.40	188.0
7	11.17	208.1	0.63	188.1							11.80	207.0
8+	15.51	213.2	0.19	234.6							15.70	213.5
Total	278.80		105.00	21.1	53.87	49.68	265.40	22.2	192.42	29.3	895.49	55.8
SOP (t)		33,572		2,219		2,676		5,895		5,647		50,008
2. Quarter												
W. rings	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			91.50	2.0								
1	17.16	51.4	39.44	33.6	20.27	42.5	129.82	16.9	270.74	16.7	477.43	20.5
2	444.95	124.6	8.35	92.1	61.86	90.4	11.01	51.0	35.22	65.9	561.39	115.2
3	112.09	150.9	2.42	106.8							114.51	150.0
4	44.60	166.0	0.01	172.8							44.61	166.0
5	21.21	199.0	0.01	184.1							21.22	199.0
6	12.66	214.0									12.66	214.0
7	9.70	219.0									9.70	219.0
8+	8.90	239.4									8.90	239.4
Total	671.27	136.8	141.73	17.9	82.13	78.56	140.83	19.6	305.96	22.3	1250.42	88.1
SOP (t)		91,829		2,539		6,452		2,755		6,829		110,222
3. Quarter												
W. rings	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			3041.30	4.9	1.57	13.1	37.32	21.4	166.05	9.1	3246.24	5.3
1	111.83	84.0	115.17	60.3	150.35	93.2	0.68	65.2	31.76	66.8	409.79	79.4
2	511.07	137.0	0.55	141.8	13.33	124.1	0.04	60.0	4.26	112.4	529.25	136.5
3	161.75	167.0	0.15	170.9							161.90	167.0
4	72.42	196.0	0.14	185.4							72.56	196.0
5	42.85	225.0	0.03	221.8							42.88	225.0
6	30.77	248.0									30.77	248.0
7	30.12	282.0									30.12	282.0
8+	59.29	300.2									59.29	300.2
Total	1020.10	161.0	3157.34	7.0	165.25		38.04	22.3	202.07	20.3	4582.80	45.1
SOP (t)		164,186		21,983		15,685		847		4,104		206,805
4. Quarter												
W. rings	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	1.65	7.0	582.85	13.1	16.52	28.9	112.08	20.7	208.69	18.4	921.79	15.5
1	39.09	98.5	30.21	46.9	146.00	90.9	5.80	41.3	111.21	80.0	332.31	83.3
2	262.93	143.3	11.47	113.0	25.07	132.0			15.73	128.9	315.20	140.6
3	142.06	171.8	1.94	114.8							144.00	171.0
4	156.27	198.5	1.93	157.1							158.20	198.0
5	26.19	227.0	3.81	195.3							30.00	223.0
6	34.06	258.0	0.04	267.9							34.10	258.0
7	20.58	261.0	0.02	278.3							20.60	261.0
8+	26.88	272.4	0.02	286.5							26.90	272.4
Total	709.71		632.29	18.4	187.59		117.88	21.7	335.63	44.0	1983.10	85.9
SOP (t)		124,378		11,640		17,064		2,557		14,759		170,399
Total Year												
W. rings	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	1.65	7.0	3715.65	6.1	18.09	27.6	149.40	20.9	374.74	14.2	4259.53	7.4
1	168.25	84.06	282.25	39.5	331.54	86.0	358.97	17.4	549.14	32.7	1690.15	46.2
2	1357.60	130.16	25.52	98.2	139.21	92.5	53.78	50.1	112.20	71.6	1688.31	120.1
3	457.63	159.58	5.48	115.9							463.11	159.1
4	326.49	180.64	2.58	161.4							329.07	180.5
5	99.29	214.96	3.91	195.5							103.20	214.2
6	86.82	240.49	0.11	238.6							86.93	240.5
7	71.57	255.88	0.65	190.9							72.22	255.3
8+	110.58	276.35	0.21	239.5							110.79	276.3
Total	2679.88	154.47	4036.36	9.5	488.84	85.67	562.15	21.4	1036.08	30.2	8803.31	61.1
SOP (t)		413,964		38,382		41,878		12,053		31,339		537,616

Table 2.2.9 Landings by country and quarter in tonnes, number of samples, number of fish measured and aged.

HERRING

Country	Quarter	Landings in '000tons	Number of samples	Number of fish measured	Number of fish aged
Belgium	1	0.0			
	2	0.0			
	3	0.0			
	4	0.1	0	0	0
	Total	0.1	0	0	0
Denmark	1	25.4	22	787	775
	2	13.0	5	289	286
	3	33.1	24	1,983	1,981
	4	50.0	38	1,830	1,817
	Total	121.5	89	4,889	4,859
France	1	1.3	0	0	0
	2	5.0	2	332	109
	3	14.0	0	0	0
	4	11.6	4	842	288
	Total	31.9	6	1,174	397
Germany	1	+	0	0	0
	2	5.5	0	0	0
	3	22.8	21	6,687	1,154
	4	7.3	16	8,372	355
	Total	35.6	37	15,059	1,509
Netherlands	1	8.0	13	1,678	857
	2	8.7	11	2,092	1,198
	3	19.7	6	1,328	650
	4	44.5	36	4,506	1,179
	Total	80.9	66	9,604	3,884
Norway (see footnote 1.)	1	0.8			
	2	58.7			
	3	53.6			
	4	12.2			
	Total	125.3	221	11,025	2,960
Sweden	1	0.0	0	0	0
	2	1.6	0	0	0
	3	1.7	0	0	
	4	2.0	0	0	0
	Total	5.3	0	0	0
UK (England)	1	+	0	0	0
	2	0.8	0	0	0
	3	11.0	0	0	
	4	2.8	0	0	0
	Total	14.6	0	0	0
UK (Scotland) (see footnote 2.)	1	0.0			
	2	3.4			
	3	43.6			
	4	8.7			
	Total	55.7	116	21,133	6,523

Footnote 1. Aged samples only. Additional length measure samples not available by quarters

Footnote 2. Data not available by quarter.

Country	Quarter	Landings in '000tons	Number of samples per 000 tons	Number of fish measured per 000 tons	Number of fish aged per 000 tons
All countries	All	470.9	1.14	133.54	42.75

Table 2.3.1.

IBTS 1-ringer indices (revised at 1995 WG meeeting)

Year class	Year of sampling	1-ringer index
1977	1979	172*
1978	1980	312*
1979	1981	431*
1980	1982	772*
1981	1983	1260
1982	1984	1443
1983	1985	2083
1984	1986	2542
1985	1987	3684
1986	1988	4530
1987	1989	2313
1988	1990	1016
1989	1991	1159
1990	1992	1162
1991	1993	2943
1992	1994	1667
1993	1995	1188

* revised according to new procedures,
but not based on retrival from database

Table 2.3.2 Denisty and abundance estimates of 0-ringers caught in February during the IBTS. Values given for year classes by areas are density estimates in numbers per square metre. Total abundance is found by multiplying density by area and summing up

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	South Bight	0-ringers abundance
Area m ² x 10 ⁹	83	34	86	102	37	93	31	31	no. in 10 ⁹
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992 ¹	0.168	0.039	0.672	0.444	0.734	0.268	0.345	0.285	190.1
1993	0.358	0.212	0.260	0.187	0.120	0.119	0.223	0.028	101.7
1994	0.148	0.024	0.417	0.381	0.332	0.148	0.252	0.169	126.9

Table 2.3.3 VPA estimates of 0-ringers and 1-ringers and the predictions from the RCT3 regression (* VPA data used in RCT3)

Year class	0-ringers			1-ringers		
	MIK index	VPA est. billions	Prediction-billions	IBTS index	VPA est. billions	Prediction billions
1977	13.1	4.7*		172	1.64*	
1978	52.1	10.6*		312	3.58*	
1979	101.1	16.7*		431	5.41*	
1980	76.7	37.8*		772	8.57*	
1981	133.9	64.5*		1260	16.94*	
1982	91.8	61.8*		1443	15.24*	
1983	115	53.5*		2083	15.89*	
1984	181.3	81.9*		2542	27.69*	
1985	177.4	97.5*		3684	33.74*	
1986	270.9	84.8*		4530	26.57*	
1987	168.9	42.1*		2313	13.70*	
1988	71.4	38.4*		1016	12.41*	
1989	25.9	36.3*		1159	12.63*	
1990	69.9	36.7*		1162	12.16*	
1991	200.7	76.1*		2943	21.52	25.6
1992	190.1	64.6	55.5	1667	17.45	16.6
1993	101.7	43.0	38.6	1188	12.40	11.9
1994	126.9	53.8	49.7			

Table 2.3.4

Prediction of 0-ringers from IBTS1 and MIK indices

Data for 2 surveys over 18 years : 1977 - 1994

Regression type = C

Tapered time weighting not applied

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .20

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1992

I-----Regression-----I						I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
MIK	1.31	.01	.64	.648	15	5.25	6.91	.729	.154
IBTS1	.96	-.86	.30	.892	15	7.42	6.25	.336	.728
VPA Mean =							5.97	.837	.117

Yearclass = 1993

I-----Regression-----I						I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
MIK	1.31	.01	.64	.648	15	4.63	6.10	.710	.161
IBTS1	.96	-.86	.30	.892	15	7.08	5.93	.335	.724
VPA Mean =							5.97	.837	.116

Yearclass = 1994

I-----Regression-----I						I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
MIK	1.31	.01	.64	.648	15	4.85	6.38	.714	.579
IBTS1									
VPA Mean =							5.97	.837	.421

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	555	6.32	.29	.19	.44		
1993	386	5.96	.28	.04	.02		
1994	497	6.21	.54	.20	.14		

Table 2.3.5

Analysis by RCT3 ver3.1 of data from file :

rct1ring.txt

Prediction of 1-ringers from IBTS1 and MIK indices

Data for 2 surveys over 17 years : 1977 - 1993

Regression type = C

Tapered time weighting not applied

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .20

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1991

	I-----Regression-----I					I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
M	1.32	1.13	.67	.620	14	5.31	8.14	.777	.101
IBTS1	.92	.54	.24	.928	14	7.99	7.90	.275	.808
VPA Mean =							7.05	.822	.090

Yearclass = 1992

	I-----Regression-----I					I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
MIK	1.32	1.13	.67	.620	14	5.25	8.07	.774	.097
IBTS1	.92	.54	.24	.928	14	7.42	7.38	.267	.816
VPA Mean =							7.05	.822	.086

Yearclass = 1993

	I-----Regression-----I					I-----Prediction-----I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
MIK	1.32	1.13	.67	.620	14	4.63	7.25	.750	.102
IBTS1	.92	.54	.24	.928	14	7.08	7.06	.266	.813
VPA Mean =							7.05	.822	.085

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	2555	7.85	.25	.18	.56		
1992	1660	7.41	.24	.16	.47		
1993	1189	7.08	.24	.04	.03		

Table 2.4.1	Estimated numbers, biomass and mean weight of autumn spawners by age, maturity and area.				
	Acoustic survey June and July 1994				
winter	numbers in millions				
rings	IVa	IVb	IVa+IVb	East of 6' E	Total
0		395.43	395.43	2931.16	3326.59
1	436.26	388.05	824.32	2822.05	3646.37
2 immature	163.06	357.46	520.52	395.94	916.46
2 mature	1313.49	985.32	2298.81	64.46	2363.27
3 immature	25.05	48.91	73.96	62.36	136.32
3 mature	589.12	198.04	787.16	33.58	820.74
4	234.87	169.27	404.14	25.28	429.42
5	211.36	136.28	347.64	15.50	363.14
6	218.36	102.45	320.82	0.00	320.82
7	288.99	38.94	327.94	0.00	327.94
8	187.63	32.66	220.29	0.00	220.29
9+	113.31	18.74	132.05	0.00	132.05
total immature	624.37	1189.85	1814.23	6211.51	8025.74
total mature	3157.13	1681.70	4838.85	138.82	4977.67
grand total	3781.50	2871.55	6653.08	6350.33	13003.41
winter	mean weight in grams				
rings	IVa	IVb	IVa+IVb	East of 6' E	Total
0					0
1	62.21	57.99	60.23	62.75	62.18
2 immature	109.86	115.09	113.46	72.63	95.82
2 mature	169.34	134.88	154.57	121.86	153.68
3 immature	132.16	140.69	137.80	127.08	132.90
3 mature	223.71	193.66	216.15	158.37	213.79
4	240.88	191.43	220.17	180.16	217.81
5	282.17	202.58	250.97	188.00	248.28
6	300.28	264.56	288.87		288.87
7	321.00	270.74	315.03		315.03
8	331.04	279.81	323.45		323.45
9+	356.25	286.70	346.38		346.38
total immature	77.46	59.27	65.54	34.41	41.45
total mature	231.62	168.53	209.69	148.69	207.99
grand total	206.16	123.26	170.38	36.91	105.20
winter	biomass in '000 t				
rings	IVa	IVb	IVa+IVb	East of 6' E	Total
0	0	0	0	0	0
1	27	23	50	177	227
2 immature	18	41	59	29	88
2 mature	222	133	355	8	363
3 immature	3	7	10	8	18
3 mature	132	38	170	5	175
4	57	32	89	5	94
5	60	28	87	3	90
6	66	27	93	0	93
7	93	11	103	0	103
8	62	9	71	0	71
9+	40	5	46	0	46
total immature	48	71	119	214	333
total mature	731	283	1015	21	1035
grand total	780	354	1134	234	1368

Table 2.4.2 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1994. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 1994 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

Age (rings)	Numbers (millions)										
	Year										
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179	3,710	3,280
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363
6	44	41	36	77	174	281	395	748	1,311	788	321
7	52	17	24	38	43	120	211	262	474	546	328
8	39	23	6	11	23	44	134	112	155	178	220
9+	41	19	8	20	14	22	43	56	163	116	132
Total	5,478	5,484	7,542	20,165	13,496	16,377	18,262	12,781	17,173	19,326	13,003
Z(2+/3+)		0.92	0.57	1.01	0.81	0.11	1.11	0.56	0.49	0.73	0.64
SSB('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035

SSB defined as all fish > maturity stage III.

Table 2.5.1

Present and historical estimates of LAI. Due to poor coverage, no index could be calculated for 1990 and 1991. The 1992 index calculated using filled-in values from a tiplicative model fit, as given in the previous year's report. The 1993 index is also culated using filled-in values in a similar fashion. For 1994 no indices are available.

Year	Buchan	Orkney & Shetland	Central North Sea	Southern North Sea	Total North Sea	West Scotland
1972	7	5779	112	171	6405	5779
1973	10	2387	734	133	5466	2442
1974	379	1284	635	25	4228	1186
1975	441	439	59	25	1141	878
1976	1	655	76	18	978	189
1977	228	1321	174	23	2268	787
1978	363	3705	462	111	6027	332
1979	200	5649	188	403	7004	1071
1980	18	3982	214	1193	6049	1436
1981	20	3939	3364	4855	22270	2154
1982	1002	3795	338	3709	9858	1890
1983	4483	3346	661	2354	12827	668
1984	4296	3538	1055	2267	14321	2133
1985	4351	10487	3802	4065	34111	2710
1986	3780	5500	2027	4780	22168	3037
1987	3308	9596	1970	3317	24101	4119
1988	12319	16502	2946	3907	44512	5947
1989	6940	17424	2205	7861	41045	4320
1990						6525
1991				8646		4430
1992	1807	9413	367	2337	15026	12251
1993	1274	9005	476	2974	15158	2941

Table 2.5.2 Comparison of data requirements and data availability for the calculation of LPE imates in 1993.

Area	Recommended Period	Available Samples
Buchan	15/9 - 7/10	22/9 - 26/9 (67)
Orkney & Shetland	10/9 - 30/9	28/9 - 30/9 (41)
Central North Sea	1/10 - 20/10	5/10 - 7/10 (74)
Southern North Sea	1/1 - 15/1	5/1 - 13/1 (117)
Western Scotland	15/9 - 7/10	3/9 - 12/09 (177) 8/10 - 19/10 (194)

Table 2.5.3. Estimates of larval production (LPE, $\cdot 10^{11}$ larvae) by area and year for the North Sea and West of Scotland areas.

Year	Buchan	Orkney & Shetland	Central North Sea	Southern North Sea	West Scotland
1972		174	23	20	
1973		95	80	10	318
1974		78	45	2	238
1975		54	46	1	157
1976		20	10	1	60
1977			67		223
1978		102	73	3	132
1979		299	57	11	118
1980		332	103	127	287
1981		225	187	406	448
1982	92	336	76	190	267
1983	277	282	64	258	112
1984	433	213	523	178	253
1985	477	314	633	206	418
1986	831	218	451	359	907
1987	200	359	331	175	423
1988	727	413	568	231	781
1989	703	730	313	275	752
1990	887	890	335	266	426
1991	437	359	270	257	632
1992	270	None	109	73	463
1993	46	77	56	186	538
1994		no indices available			

Table 2.5.4. Number of samples taken and sampling effort for the herring larval surveys by year.

1. All areas

Year	No. of samples
1986/7	2 040
1987/8	1 978
1988/9	1 886
1989/0	1 672
1990/1	1 005
1991/2	931
1992/3	739
1993/4	862 (of which 54 not usable)
1994/5	157

2. North Sea only

Year	No. of Samples	Vessel-Days in Survey
1988/9	1636	105
1989/0	1565	110
1990/1	638	82
1991/2	738	59
1992/3	504	55
1993/4	491	35 (of which 6 unusable)
1994/5	157	12

Table 2.5.5. Recent and historical estimates of the abundances of larvae in the three sampling units that were covered in 1994 and reported on in this document.

Year	Central North Sea		Southern North Sea
	16/9-30/9	1/10-15/10	12/12-31/12
1972	91	135	22
1973	862	1400	7
1974		1238	2
1975	140	79	4
1976	217	5	
1977	286	91	2
1978	132	297	53
1979	132	507	3
1980	190	15	291
1981	1044	239	1481
1982	65	1079	2108
1983	282	70	539
1984	2426	829	565
1985	13060	1803	1445
1986	6112	253	845
1987	4922	2045	941
1988	4074	1965	1645
1989	5012	2362	1872
1990	1295	1193	3392
1991	2112	1370	4522
1992	167	170	
1993	686	107	1622
1994	1465	50	450

Table 2.6.1 North sea Herring.
Mean weighth (g) at age (w.r.) and year class weighted by number caught

Cathes in : 1994

Division	Quarter	0 1993	1 1992	2 1991	3 1990	4 1989	5 1988	6 1987	7 1986	8 1985	9 1984
IV a (W of 2E)	I		43	72	153	171	196	221	223	234	235
	II		63	126	155	171	206	218	218	226	271
	III		80	159	211	233	263	262	288	299	313
	IV	14	74	148	177	228	215	263	265	267	282
	Total	14	74	140	180	207	235	250	265	282	299
IV a (E of 2 E)	I		56	98	118	155	175	181	172	205	212
	II			131	159	182	200	213	225	246	255
	III		68	126	136	164	173	218	227	229	287
	IV			169	206	248	247	266	270	282	283
	Total		68	123	158	191	206	241	242	262	278
IV b	I		15	76	153	167	171	226	204		
	II	2	39	114	135	167	171	231	209	322	
	III	5	72	122	152	176	205	234	257	254	244
	IV	13	70	158	178	195	226	249	246	258	249
	Total	6	54	122	150	177	205	237	251	255	245
IVc + VIIId	I		18	83	101	114	144	145	158	166	166
	II			94	101	117	156	187	187	192	210
	III		69	128	177	197	236	255	197		
	IV	13	96	118	157	193	209	234	239	261	256
	Total	13	91	117	145	172	191	209	224	229	218
IVa	Total	14	70	135	171	201	223	246	258	278	295
IVa + IVb	I		15	97	124	160	188	207	211	234	234
	II	2	39	124	151	172	201	216	221	237	262
	III	5	72	137	167	196	225	248	282	295	308
	IV	13	71	158	190	225	232	264	267	277	281
	Total	6	55	131	164	192	218	245	258	277	292
Total North Sea	I		15	97	113	120	170	188	207	219	206
	II	2	39	124	150	166	199	214	219	235	259
	III	5	72	137	167	196	225	248	282	295	308
	IV	13	76	142	171	198	223	258	261	272	273
	Total	6	56	130	159	181	214	240	255	273	281

Table 2.6.2 Comparison between mean weights (g) at age in catch of North Sea Herring (adults) from earlier years and 1985-1994.

Division	Age in winter rings								
	Year	2	3	4	5	6	7	8	9+
IVa	1986	123	158	183	209	222	246	253	263
	1987	118	157	186	214	237	260	278	304
	1988	126	150	176	200	218	237	260	263
	1989	129	157	175	210	233	246	268	256
	1990	123	154	177	194	229	234	251	295
	1991	146	164	181	198	214	231	263	275
	1992	149	184	189	208	223	240	243	285
	1993	133	156	193	210	234	249	268	319
	1994	135	171	201	223	246	258	278	295
IVb	1986	120	157	191	219	232	220	207	237
	1987	70	131	179	215	233	225	273	244
	1988	98	136	175	195	208	244	228	205
	1989	93	162	199	225	280	276	273	333
	1990	102	145	194	219	250	272	259	277
	1991	119	173	196	220	225	277	257	263
	1992	81	179	198	213	232	255	272	313
	1993	102	146	199	220	236	261	275	306
	1994	122	150	177	205	237	251	255	245
IVa+IVb	1985	133	171	200	216	233	261	270	293
	1986	122	158	184	210	223	245	253	263
	1987	99	152	186	214	237	259	278	304
	1988	112	147	176	199	217	238	257	263
	1989	116	158	179	212	237	250	269	259
	1990	113	152	181	198	232	238	252	290
	1991	131	167	184	203	217	239	262	272
	1992	100	183	191	209	224	243	250	290
	1993	116	152	195	212	234	251	269	317
IVc+VIId	1994	131	164	192	218	245	258	277	292
	1985	113	124	148	170	168	212	207	193
	1986	108	139	164	185	208	174	202	232
	1987	105	128	148	164	198	211	197	234
	1988	103	132	156	178	197	185	165	
	1989	110	127	151	182	198	201	198	179
	1990	118	131	152	171	195	216	208	231
	1991	123	165	184	200	212	196	237	161
	1992	100	183	191	209	224	243	250	290
Total North Sea	1993	113	139	152	174	182	191	211	216
	1994	117	145	172	191	209	224	229	218
	1985	128	164	194	211	220	258	270	292
	1986	121	153	182	207	221	238	252	262
	1987	99	149	180	211	234	258	278	295
	1988	111	145	174	197	216	237	253	263
	1989	115	153	173	208	231	247	265	259
	1990	114	149	177	193	229	236	250	287
	1991	130	166	184	203	217	235	259	271
	1992	103	175	189	207	223	237	249	287
	1993	115	145	189	204	228	244	256	310
	1994	130	159	181	214	240	255	273	281

Table 2.6.3 Herring mean weight at age in the third quarter in Divisions IVa and IVb.

AGE (w.r.)	Mean weights (g) at age in the catch											
	Third quarter (Divisions IVa and IVb)								July Acoustic Survey			
	1987	1988	1989	1990	1991	1992	1993	1994	1991	1992	1993	1994
1	54	58	42	58	73	51	53	55	65	78	69	60
2	134	124	126	128	164	127	145	131	158	142	115	138
3	182	179	179	180	189	200	161	164	198	209	147	209
4	219	207	207	208	210	215	179	192	224	219	202	220
5	248	244	244	228	229	235	199	218	236	243	225	251
6	265	274	274	256	246	252	221	245	260	255	277	289
7	286	288	288	267	276	276	239	258	275	272	286	315
8	310	296	296	272	296	286	240	277	298	312	305	323
9+	342	350	350	295	293	330	283	292	317	311	340	346

Table 2.7.1 Time series of spawning stock indices, and the spawning stock from the converged part of the separable VPA ('000 t).

Year	SSB VPA	SSB LPE	SSB Acoustic	SSB IBTS
1972	289	146	-	-
1973	233	116	-	-
1974	162	77	-	-
1975	80	61	-	-
1976	77	20	-	-
1977	45	-	-	-
1978	61	108	-	-
1979	104	224	-	-
1980	128	365	-	-
1981	194	636	305	5.94
1982	280	480	402	12.55
1983	433	635	440	14.07
1984	729	871	807	35.64
1985	763	1,022	697	37.46
1986	815	1,244	942	28.66
1987	944	699	667 ¹	50.83
1988	1,146	1,249	801 ²	35.99
1989	1,391	1,328	1,490 ³	84.76
1990	1,260	1,547	2,009 ⁴	89.50
1991	-	889	1,743 ⁵	46.52
1992	-	860	1,457 ⁶	38.68
1993	-	-	1,102 ⁷	26.03
1994	-	-	967 ⁸	-

¹Reduced by 150,000 t (catches of spawners between time of the survey (15 July) and 1 November).

²Reduced by 94,000 t (catches of spawners between time of the survey (15 July) and 1 September).

³Reduced by 147,000 t (catches of spawners between time of the survey and 1 September).

⁴Reduced by 165,000 t (catches of spawners between time of the survey (13 July) and 27 September).

⁵Reduced by 131,000 t (catches of autumn spawners between time of the survey (15 July) and 15 September).

⁶Reduced by 88,000 t (catches of autumn spawners between time of the survey (15 July) and 24 September).

⁷Reduced by 81,000 t (catches of autumn spawners between time of survey (15 July) and 10 September).

⁸Reduced by 68,000 t (catch of autumn spawners between time of survey (15 July) and 20 August).

Table 2.7.2 Input data for ICA North Sea

```

Name of age-structured index file (Enter if none)--> nsherrfl.dat
Name of the SSB index file (Enter if none)--> nsherr.rct
'NORTH SEA HERRING SSB INDICES '

Last year of catch data set is 1994
No of years for separable constraint ? --> 6
  Reference age for separable constraint ? --> 4
    S to be fixed on last age ? --> 1
First age for calculation of reference F --> 2
Last age for calculation of reference F --> 6
  Use default weighting (Y/N) ? --> n
Enter relative weights at age
  Weight for age 0 --> .01
  Weight for age 1 --> .5
  Weight for age 2 --> 1
  Weight for age 3 --> 1
  Weight for age 4 --> 1
  Weight for age 5 --> 1
  Weight for age 6 --> 1
  Weight for age 7 --> 1
  Weight for age 8 --> 1
  Weight for age 9 --> 1

Enter relative weights by year
  Weight for year 1992 --> 1
  Weight for year 1993 --> 1
  Weight for year 1994 --> 1
Specify weights for year and age:
Enter year, age, new weight or -1,-1,-1 to finish
-1,-1,-1
Is the last age of index 1 a plus group ? (Y/N)--> y
Is the last age of index 2 a plus group ? (Y/N)--> n
Is the last age of index 3 a plus group ? (Y/N)--> y
Is the last age of index 4 a plus group ? (Y/N)--> n

Model for SSB index 1 is to be linear
Model for aged index 1 is to be linear
Model for aged index 1 is to be linear
Model for aged index 2 is to be linear
Model for aged index 3 is to be linear
Model for aged index 4 is to be linear

Do you want to fit a stock-recruit relationship ? --> y

file name stocki/recruitment dta: srr.dat
-----
No of years for separable analysis :      3
Age range in the analysis          :      0      9
Year range in the analysis         :    1976    1994
Number of indices of SSB           :      1
Number of age-structured indices   :      4
Parameters to estimate              :     42
-----

Enter lowest feasible F --> .05
Enter highest feasible F --> 1

Enter weight for biomass index 1 --> 1
Enter weight for aged index 1 at age 2 --> 1
Enter weight for aged index 1 at age 3 --> 1
Enter weight for aged index 1 at age 4 --> 1
Enter weight for aged index 1 at age 5 --> 1
Enter weight for aged index 2 at age 1 --> 1
Enter weight for aged index 3 at age 2 --> 1
Enter weight for aged index 3 at age 3 --> 1
Enter weight for aged index 3 at age 4 --> 1
Enter weight for aged index 3 at age 5 --> 1
Enter weight for aged index 3 at age 6 --> 1
Enter weight for aged index 3 at age 7 --> 1
Enter weight for aged index 3 at age 8 --> 1
Enter weight for aged index 3 at age 9 --> 1
Enter weight for aged index 4 at age 0 --> 1
Enter weight for stock-recruit model --> 1

You should enter estimates of the extent to which
errors in each age of the age structured indices
are correlated. These may range from zero
(independence) to 1 (correlated errors) .

```

Table 2.7.2 (continued)

Enter value for aged index 1 --> 1
Enter value for aged index 2 --> 1
Enter value for aged index 3 --> 1
Enter value for aged index 4 --> 1
Do you want to shrink the final populations ? (Y/N) --> n
Parameters to be estimated (Max 75): 39
Number of observations (Max 500): 190
Warning: Stock/Recruit estimates treated as data.
SSB Index Weights
1.000

Aged Index Weights
Aged index 1
Ages: 2 3 4 5
Wts : .250 .250 .250 .250
Aged index 2
Ages: 1
Wts : 1.000
Aged index 3
Ages: 2 3 4 5 6 7 8 9
Wts : .125 .125 .125 .125 .125 .125 .125 .125
Aged index 4
Ages: 0
Wts : 1.000
Stock -Recruit Wt : 1.000

F in 1994 at age 4 is : .58541 in iteration 1

Total weighted SSQ is : 15.079260543403600

Unweighted Residuals About the Model fit

	Start SSQ	End SSQ	df	Variance	IV Wt
Separable model:	.4267	3.5218	6	.5870	1.70369
Biomass idx 1	.4859955	.4562342	9	.0507	11.57880
Aged index 1	18.1213955	17.2342552	48	.3590	1.63477
Aged index 2	1.0798295	1.0356233	16	.0647	9.06832
Aged index 3	6.0921980	3.7385334	40	.0935	6.28011
Aged index 4	4.1240172	3.7252923	17	.2191	2.67854

Task completed in : 157.802500 seconds.

Table 2.7.3 Output data ICA NORTH SEA

CATCH	NUMBERS AT AGE (Millions)																			
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	264.	238.	257.	130.	542.	1263.	9520.	11957.	13297.	6662.	4179.	3664.	8036.	3123.	2984.	1252.	2307.	10006.	9892.	4260.
1	2461.	127.	144.	169.	159.	245.	872.	1116.	2449.	1737.	3228.	4723.	6675.	7763.	3070.	2902.	2067.	2231.	3688.	1690.
2	542.	902.	45.	5.	34.	134.	284.	299.	574.	1095.	1316.	1246.	2087.	2203.	1555.	864.	1095.	1244.	1134.	1688.
3	260.	117.	186.	6.	10.	92.	57.	230.	216.	422.	1173.	827.	652.	1076.	1331.	749.	538.	429.	587.	463.
4	141.	52.	11.	5.	10.	32.	40.	34.	105.	193.	366.	458.	456.	379.	790.	827.	531.	350.	294.	329.
5	57.	35.	7.	0.	2.	22.	29.	14.	26.	78.	124.	128.	240.	252.	207.	372.	484.	349.	208.	103.
6	16.	6.	4.	0.	0.	2.	23.	7.	23.	22.	43.	61.	73.	126.	121.	77.	198.	364.	218.	87.
7	9.	4.	2.	0.	1.	1.	19.	8.	13.	24.	20.	20.	23.	38.	60.	52.	38.	148.	181.	72.
8	3.	1.	1.	0.	1.	0.	6.	4.	11.	11.	13.	13.	8.	15.	19.	28.	25.	38.	84.	66.
9	1.	0.	0.	0.	0.	0.	1.	1.	12.	18.	16.	15.	8.	8.	9.	11.	13.	23.	40.	44.
INDICES OF SPAWNING STOCK BIOMASS																				
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993									
1	.635E+03	.871E+03	.102E+04	.124E+04	.699E+03	.125E+04	.133E+04	.155E+04	.889E+03	.860E+03	-.110E+02									
AGE - STRUCTURED INDICES																				
INDEX : 1 from	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to	1983 to
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995							
2	.109E+03	.161E+03	.716E+03	.661E+03	.838E+03	.410E+04	.775E+03	.580E+03	.794E+03	.377E+03	.762E+03	.109E+04	.128E+04							
3	.418E+02	.747E+02	.256E+03	.235E+03	.117E+03	.783E+03	.411E+03	.322E+03	.283E+03	.181E+03	.236E+03	.199E+03	.153E+03							
4	.141E+02	.318E+02	.262E+02	.565E+02	.555E+02	.554E+02	.864E+02	.271E+03	.250E+03	.630E+02	.445E+02	.636E+02	.462E+02							
5	.337E+02	.690E+01	.364E+02	.172E+02	.436E+02	.260E+02	.100E+02	.703E+02	.170E+03	.102E+03	.637E+02	.400E+02	.930E+01							
INDEX : 2 from	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to	1979 to
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995			
1995																				
1	.172E+03	.312E+03	.431E+03	.772E+03	.126E+04	.144E+04	.208E+04	.254E+04	.368E+04	.453E+04	.231E+04	.102E+04	.116E+04	.116E+04	.294E+04	.167E+04				
.119E+04																				
INDEX : 3 from	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to	1989 to
	1989	1990	1991	1992	1993	1994														
2	.373E+07	.297E+07	.283E+07	.418E+07	.371E+07	.328E+07														
3	.375E+07	.353E+07	.150E+07	.163E+07	.189E+07	.957E+06														
4	.161E+07	.337E+07	.210E+07	.140E+07	.909E+06	.429E+06														
5	.488E+06	.135E+07	.198E+07	.151E+07	.795E+06	.363E+06														
6	.281E+06	.395E+06	.748E+06	.131E+07	.788E+06	.321E+06														
7	.120E+06	.211E+06	.262E+06	.474E+06	.546E+06	.328E+06														
8	.440E+05	.134E+06	.112E+06	.155E+06	.178E+06	.220E+06														
9	.220E+05	.430E+05	.560E+05	.163E+06	.116E+06	.132E+06														

cont'd.

Table 2.7.3 (continued)

INDEX : 4 from 1978 to 1995																				
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993				
1994	1995																			
0	.131E+02	.521E+02	.101E+03	.767E+02	.134E+03	.918E+02	.115E+03	.181E+03	.177E+03	.271E+03	.169E+03	.714E+02	.259E+02	.699E+02	.201E+03	.190E+03				
.102E+03	.127E+03																			
FISHING MORTALITY																				
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.1510	.1437	.0966	.0450	.0838	.1263	.4853	.3377	.4047	.2188	.0859	.0619	.1616	.1247	.1294	.0557	.1041	.1128	.1340	.1055
1	.6854	.2372	.2896	.1978	.1647	.1134	.2869	.2273	.2551	.1986	.3827	.3156	.3692	.5892	.4251	.4402	.2907	.2556	.3036	.2391
2	1.2902	1.3249	.2116	.0235	.0934	.3583	.3249	.2623	.3061	.3037	.4052	.4542	.4023	.3557	.4034	.3627	.5520	.4729	.5616	.4424
3	1.4983	1.3497	1.3557	.0396	.0644	.4121	.2698	.5103	.3275	.4138	.6685	.5184	.4916	.4001	.4046	.3696	.4322	.4771	.5665	.4463
4	1.3450	1.7039	.3735	.0962	.0870	.2861	.2962	.2406	.4392	.5131	.7289	.5709	.5753	.5626	.5462	.4490	.4612	.6197	.7360	.5798
5	1.8072	1.4676	1.1140	.0140	.0481	.2426	.3912	.1497	.2662	.5958	.6449	.5356	.5896	.6451	.6078	.4761	.4568	.5711	.6782	.5343
6	1.2514	.9270	.5827	.0674	.0105	.0614	.3814	.1352	.3316	.3254	.6981	.6827	.5920	.6300	.6517	.4236	.4451	.6631	.7875	.6204
7	1.9639	1.3977	.5384	.0438	.3674	.0849	.8338	.1943	.3577	.6131	.4992	.7350	.5301	.6145	.6100	.5803	.3390	.6180	.7339	.5781
8	1.6777	1.3756	.7725	.1114	.1604	.2817	.4836	.3260	.4060	.4994	.7013	.6516	.6230	.6974	.6445	.5666	.5289	.6197	.7360	.5798
9	1.6777	1.3756	.7725	.1114	.1604	.2817	.4836	.3260	.4060	.4994	.7013	.6516	.6230	.6974	.6445	.5666	.5289	.6197	.7360	.5798
NUMBERS AT AGE (Millions)																				
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1995																				
0	2941.	2783.	4378.	4653.	10590.	16666.	37665.	64208.	61160.	52681.	79714.	96019.	84052.	41722.	38485.	36388.	36607.	63556.	52876.	35488.
50384.																				
1	7427.	930.	887.	1462.	1636.	3583.	5404.	8529.	16851.	15010.	15572.	26910.	33202.	26306.	13550.	12440.	12661.	12136.	20886.	17013.
11748.																				
2	839.	1377.	270.	244.	441.	511.	1177.	1492.	2500.	4803.	4527.	3907.	7220.	8444.	5369.	3258.	2947.	3483.	3458.	5672.
4928.																				
3	360.	171.	271.	162.	177.	298.	264.	630.	850.	1364.	2626.	2237.	1838.	3577.	4383.	2657.	1680.	1257.	1608.	1461.
2700.																				
4	198.	66.	36.	57.	127.	136.	162.	165.	310.	502.	738.	1102.	1090.	920.	1963.	2394.	1503.	893.	639.	747.
765.																				
5	71.	47.	11.	23.	47.	106.	92.	109.	118.	181.	272.	322.	563.	555.	474.	1029.	1383.	858.	435.	277.
379.																				
6	23.	11.	10.	3.	20.	41.	75.	56.	85.	81.	90.	129.	171.	283.	263.	234.	578.	792.	438.	200.
147.																				
7	11.	6.	4.	5.	3.	18.	35.	46.	45.	55.	53.	41.	59.	85.	136.	124.	138.	335.	369.	180.
97.																				
8	4.	1.	1.	2.	4.	2.	15.	14.	35.	28.	27.	29.	18.	31.	42.	67.	63.	89.	164.	160.
92.																				
9	2.	1.	1.	1.	2.	5.	5.	11.	16.	30.	32.	27.	26.	21.	24.	31.	50.	60.	73.	102.
133.																				

cont'd.

Table 2.7.3 (continued)

19	8	160458.	113819.	226206.
Separable Model: Populations at age 8				
20	1992	89272.8137	60499.7512	131730.0504
21	1993	163523.2839	118476.0416	225698.4958
Recruitment in Year 1995				
22	0	50383544.0402	33583199.6212	75588435.2500
SSB Index catchabilities				
23	1	Linear Model : Q	.11784E-02	.10411E-02 .13339E-02
Age-structured index catchabilities				
Age-Structured Index 1				
Linear model fitted. Slopes at age:				
24	2 Q	.16382E-03	.13134E-03	.20434E-03
25	3 Q	.11046E-03	.88452E-04	.13794E-03
26	4 Q	.70356E-04	.56286E-04	.87943E-04
27	5 Q	.40580E-04	.32426E-04	.50785E-04
Age-Structured Index 2				
Linear model fitted. Slopes at age:				
28	1 Q	.12312E-03	.11141E-03	.13606E-03
Age-Structured Index 3				
Linear model fitted. Slopes at age:				
29	2 Q	.13349E+01	.84487E+00	.21092E+01
30	3 Q	.14320E+01	.90507E+00	.22658E+01
31	4 Q	.16266E+01	.10272E+01	.25758E+01
32	5 Q	.20319E+01	.12808E+01	.32234E+01
33	6 Q	.21925E+01	.13792E+01	.34853E+01
34	7 Q	.21527E+01	.13498E+01	.34330E+01
35	8 Q	.21581E+01	.13445E+01	.34642E+01
36	9 Q	.20783E+01	.12982E+01	.33272E+01
Age-Structured Index 4				
Linear model fitted. Slopes at age:				
37	0 Q	.33231E-05	.30138E-05	.36642E-05
Parameters of the B.-H. stock-recruit relationship				
38	a	.6602507E+08	.5659705E+08	.7702362E+08
39	b	.5097341E+06	.3836383E+06	.6772756E+06

STOCK SUMMARY						

Year	Recruits	Total B	Spawn B	Landings	Yld/SSB	Ref. F
	x10 ⁻⁶	tonnes	tonnes	tonnes		Fbar 2- 6
1975	2941.	685360.	83755.	312800.	3.7347	1.4384
1976	2783.	364906.	80910.	174800.	2.1604	1.3546
1977	4378.	217634.	52032.	46000.	.8841	.7275
1978	4653.	232406.	69831.	11000.	.1575	.0482
1979	10590.	390161.	113471.	25100.	.2212	.0607
1980	16666.	638141.	138567.	70764.	.5107	.2721
1981	37665.	1162071.	202536.	174879.	.8634	.3327
1982	64208.	1838445.	284969.	275079.	.9653	.2596
1983	61160.	2455784.	431837.	387202.	.8966	.3341
1984	52681.	2752343.	716936.	409489.	.5712	.4304
1985	79714.	3152899.	734608.	609108.	.8292	.6291
1986	96019.	4064390.	770133.	660553.	.8577	.5524
1987	84052.	3883051.	877932.	773411.	.8809	.5302
1988	41722.	3482920.	1067506.	875923.	.8205	.5187
1989	38485.	3354985.	1286067.	768886.	.5979	.5228
1990	36388.	3205308.	1138269.	619963.	.5447	.4162
1991	36607.	3129598.	993144.	635929.	.6403	.4695
1992	63556.	2956064.	777997.	694206.	.8923	.5608
1993	52876.	3132395.	483611.	647435.	1.3388	.6660
1994	35488.	2899310.	789740.	600000.	.7597	.5246

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year			
1	1992	.6197	.4917 .7812
2	1993	.7360	.5779 .9373
3	1994	.5798	.4317 .7787
Separable Model: Selection (S) by age			
4	0	.1820	.0354 .9359
5	1	.4125	.2806 .6064
6	2	.7631	.5621 1.0361
7	3	.7698	.5678 1.0437
	4	1.0000	Fixed : Reference age
8	5	.9215	.6870 1.2361
9	6	1.0700	.8055 1.4214
10	7	.9971	.7497 1.3263
	8	1.0000	Fixed : last true age
Separable Model: Populations in year 1994			
11	0	35488003.	27862437. 45200580.
12	1	17012843.	13404024. 21593278.
13	?	5672004.	4535892. 7092681.
14	3	1460720.	1135265. 1879475.
15	4	747043.	572625. 974589.
16	5	276809.	208022. 368343.
17	6	199558.	146399. 272021.
18	7	180469.	128941. 252590.

cont'd.

Table 2.7.3 (continued)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals
 (log(Observed Catch)-log(Expected Catch))
 and weights (W) used in the analysis.

Age	1992	1993	1994	
0	.83854E+00	.84791E+00	.63096E+00	.10000E-01
1	.23306E+00	.40042E-01	-.32201E+00	.50000E+00
2	.81285E-01	-.13817E+00	-.48009E-01	.10000E+01
3	-.16032E-01	-.80693E-01	-.36189E-01	.10000E+01
4	-.11904E+00	-.78740E-01	.46060E-01	.10000E+01
5	-.21805E-01	.14530E-01	-.59407E-01	.10000E+01
6	-.10231E-01	-.49419E-01	-.15252E-01	.10000E+01
7	-.15309E-02	-.14728E-01	-.46794E-01	.10000E+01
8	-.37299E-01	.30656E-01	-.18024E-01	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	

Biomass Index Residuals: log(Observed Index) - log(Expected Index)

Idx	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.22141E+00	.30486E-01	.16601E+00	.31536E+00	-.39209E+00	-.71505E-02	-.13208E+00	.14264E+00	-.27495E+00	-.63958E-01	-.10000E+01

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1995												
2	-.12448E+01	-.15082E+01	.56458E-01	.13021E+00	-.25339E+00	.11717E+01	-.35045E-01	.16918E+00	.60841E+00	-.31391E+00	.40862E+00	.25612E+00
3	-.74111E+00	-.62142E+00	-.12171E-01	.43426E-01	-.46119E+00	.76189E+00	-.85186E-01	.16681E+00	.50449E+00	.35327E+00	.38394E+00	.29376E+00
4	-.36475E+00	-.24889E-01	-.57628E+00	-.22922E+00	-.23589E+00	-.69894E-01	-.38512E+00	.54681E+00	.93327E+00	.96808E-01	.99060E-01	.27905E+00
5	.10821E+01	-.71172E+00	.73416E+00	-.16552E+00	.33919E+00	-.32438E+00	-.12445E+01	.22988E+00	.70975E+00	.25632E+00	.16810E+00	.15692E+00

Aged Index 2

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1991												
1	-.66653E-02	-.20150E+00	-.26688E+00	-.14805E+00	-.33551E+00	-.93677E-01	.26126E+00	-.94716E-01	.72894E-01	.54213E+00	.51076E+00	-.21926E+00
	.12773E+00	-.89929E-01	.30337E+00	-.67256E-01	-.35694E-01							

cont'd.

Table 2.7.3 (continued)

Aged Index 3

Age	1989	1990	1991	1992	1993	1994
2	-.26615E+00	-.17032E-01	.13937E+00	.31871E+00	.25550E+00	-.42823E+00
3	-.18255E+00	.23831E+00	-.12444E+00	.27326E+00	.22416E+00	-.42651E+00
4	-.32937E+00	.15728E+00	.15653E+00	.35954E+00	.32636E+00	-.66726E+00
5	-.29155E+00	-.12034E+00	-.43704E-01	.22586E+00	.32308E+00	-.89019E-01
6	-.30708E+00	.27457E-01	-.22786E+00	.13743E+00	.28952E+00	.86482E-01
7	-.50308E+00	.13724E+00	.11237E+00	-.25546E-01	.82645E-01	.20371E+00
8	-.30853E+00	.29085E+00	.15339E+00	.17833E+00	-.22465E+00	-.79781E-01
9	-.39874E+00	-.42089E-01	-.27982E+00	.65703E+00	.19310E+00	-.10442E+00

Aged Index 4

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1990	1991	1992	1993	1994	1995							
0	.95509E-01	.66329E+00	.88337E+00	-.11840E+00	-.13151E+00	-.44360E+00	-.11553E+00	-.10772E+00	-.32157E+00	.25981E+00	.47855E+00	-.30054E+00
	.12770E+01	-.27807E+00	.22719E+00	.36219E+00	.12831E+00	-.13045E-09						

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1992 to 1994

Variance : .3249
 Skewness test statistic : 5.3475
 Kurtosis test statistic : 4.8844
 Partial chi-square : .1367
 Probability of chi-square : .9999
 Degrees of freedom : 6

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Linear catchability relationship assumed.
 Last age is a plus-group.

Variance : .0498
 Skewness test statistic : -.4613
 Kurtosis test statistic : -.5505
 Partial chi-square : .0653

cont'd.

Table 2.7.3 (continued)

Probability of chi-square : 1.0000
 Number of observations : 10
 Degrees of freedom : 9
 Weight in the analysis : 1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	2	3	4	5
Variance	:	.5270	.2266	.1665	.5149
Skewness test stat.	:	-1.1038	-.2874	1.2721	-.7084
Kurtosis test stat.	:	.1228	-.8372	.2122	-.4971
Partial chi-square	:	.9759	.5288	.4632	1.9574
Prob. of chi-square	:	1.0000	1.0000	1.0000	.9995
Number of data	:	13	13	13	13
Degrees of freedom	:	12	12	12	12
Weight in analysis	:	.2500	.2500	.2500	.2500

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

Age	:	1
Variance	:	.0664
Skewness test stat.	:	1.6162
Kurtosis test stat.	:	-.1144
Partial chi-square	:	.1449
Prob. of chi-square	:	1.0000
Number of data	:	17
Degrees of freedom	:	16
Weight in analysis	:	1.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 3

Linear catchability relationship assumed.

Age	:	2	3	4	5	6	7	8	9
Variance	:	.0882	.0825	.1677	.0529	.0514	.0667	.0584	.1438
Skewness test stat.	:	-.3819	-.3736	-.7776	.3225	-.2490	-1.4537	-.1138	.8210
Kurtosis test stat.	:	-.6723	-.6928	-.4796	-.6010	-.6369	.2890	-.7830	-.2273
Partial chi-square	:	.0290	.0287	.0608	.0196	.0194	.0272	.0254	.0647
Prob. of chi-square	:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9999

Table 2.7.3 (continued)

Number of data	:	6	6	6	6	6	6	6
Degrees of freedom	:	5	5	5	5	5	5	5
Weight in analysis	:	.1250	.1250	.1250	.1250	.1250	.1250	.1250

DISTRIBUTION STATISTICS FOR ln AGED INDEX 4

Linear catchability relationship assumed.

Age	:	0
Variance	:	.2282
Skewness test stat.	:	-1.0459
Kurtosis test stat.	:	1.1330
Partial chi-square	:	.9157
Prob. of chi-square	:	1.0000
Number of data	:	18
Degrees of freedom	:	17
Weight in analysis	:	1.0000

Table 2.7.4 Ouput VPA 1947-1994

Run title : Herring, North Sea (run: HS1/HS1)

At 5-Apr-95 16:36:13

Traditional vpa using file input for terminal F

Table 8	Fishing mortality (F) at age							
YEAR,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE								
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0039,	.0074,
1,	.0000,	.0002,	.0000,	.0000,	.0448,	.0706,	.0858,	.1077,
2,	.1251,	.0456,	.0692,	.1149,	.1822,	.3072,	.3095,	.3008,
3,	.1684,	.2652,	.1699,	.2228,	.3286,	.2543,	.4235,	.4977,
4,	.1929,	.1846,	.2340,	.2313,	.4322,	.3407,	.3247,	.4503,
5,	.2108,	.2504,	.2180,	.2400,	.3475,	.3718,	.3339,	.3901,
6,	.2682,	.2742,	.4164,	.2719,	.3157,	.4127,	.4473,	.4678,
7,	.2811,	.1987,	.4009,	.3421,	.2151,	.4609,	.4127,	.6896,
8,	.2250,	.2350,	.2890,	.2620,	.3290,	.3690,	.3900,	.5020,
+gp,	.2250,	.2350,	.2890,	.2620,	.3290,	.3690,	.3900,	.5020,
FBAR 2- 6,	.1931,	.2040,	.2215,	.2162,	.3212,	.3374,	.3678,	.4213,

Table 8	Fishing mortality (F) at age									
YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
0,	.0052,	.0053,	.0031,	.0044,	.0000,	.0257,	.0186,	.0049,	.0148,	.0126,
1,	.2073,	.1549,	.2485,	.1388,	.2175,	.2554,	.1291,	.0896,	.1239,	.3084,
2,	.3583,	.5323,	.3912,	.4987,	.4184,	.4238,	.6153,	.2495,	.2974,	.3884,
3,	.3746,	.4326,	.4463,	.4703,	.5035,	.3118,	.3378,	.6235,	.2745,	.4121,
4,	.3931,	.3081,	.4054,	.3388,	.4294,	.3019,	.3793,	.3963,	.2251,	.3684,
5,	.4431,	.3233,	.3094,	.5030,	.3902,	.2234,	.3440,	.4757,	.1387,	.3044,
6,	.4126,	.4396,	.4329,	.1875,	.4945,	.2948,	.3015,	.6223,	.1547,	.2153,
7,	.2742,	.2930,	.6185,	.2385,	.2054,	.4422,	.2309,	.4416,	.1851,	.2309,
8,	.3810,	.3610,	.4450,	.3490,	.4060,	.3160,	.3200,	.5150,	.1960,	.3060,
+gp,	.3810,	.3610,	.4450,	.3490,	.4060,	.3160,	.3200,	.5150,	.1960,	.3060,
FBAR 2- 6,	.3963,	.4072,	.3970,	.3997,	.4472,	.3111,	.3956,	.4734,	.2181,	.3378,

Traditional vpa using file input for terminal F

Table 8	Fishing mortality (F) at age									
YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	.0071,	.0215,	.0256,	.0348,	.0082,	.0351,	.0339,	.0583,	.0459,	.0747,
1,	.2460,	.1852,	.2981,	.3002,	.3291,	.2680,	.6019,	.5776,	.6736,	.4488,
2,	.7752,	.5915,	.4222,	1.3278,	.7842,	.9727,	.8823,	.8113,	1.0198,	1.0275,
3,	.7371,	.7080,	.8030,	1.8710,	.9136,	1.2662,	1.2143,	.8008,	1.3299,	.9672,
4,	.7758,	.5692,	.9238,	1.0661,	.8723,	1.3357,	1.2241,	.7988,	.9860,	.9850,
5,	.6544,	.8326,	.8200,	1.2315,	1.0391,	.8713,	1.0986,	.5471,	.9492,	1.1797,
6,	.5112,	.3849,	1.0037,	1.1456,	1.8816,	1.0368,	2.5323,	.5323,	1.3615,	1.0717,
7,	.3978,	.3782,	1.4745,	1.5634,	1.1959,	3.3513,	2.0956,	.0894,	.8516,	.7478,
8,	.6180,	.5760,	1.0120,	1.3930,	1.2090,	1.2590,	.4990,	.3970,	1.2600,	1.5990,
+gp,	.6180,	.5760,	1.0120,	1.3930,	1.2090,	1.2590,	.4990,	.3970,	1.2600,	1.5990,
FBAR 2- 6,	.6908,	.6172,	.7945,	1.3284,	1.0982,	1.0965,	1.3903,	.6981,	1.1293,	1.0462,

cont'd.

Table 2.7.4 (continued)

Table 8	Fishing mortality (F) at age									
YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	.1512,	.1437,	.0965,	.0450,	.0838,	.1262,	.4836,	.3363,	.3999,	.2152,
1,	.6855,	.2376,	.2897,	.1977,	.1645,	.1134,	.2867,	.2261,	.2536,	.1954,
2,	1.2912,	1.3256,	.2120,	.0235,	.0934,	.3576,	.3248,	.2621,	.3041,	.3013,
3,	1.4987,	1.3537,	1.3584,	.0397,	.0644,	.4119,	.2691,	.5101,	.3272,	.4100,
4,	1.3464,	1.7057,	.3759,	.0966,	.0872,	.2864,	.2960,	.2399,	.4389,	.5125,
5,	1.8113,	1.4737,	1.1184,	.0142,	.0482,	.2433,	.3917,	.1496,	.2651,	.5951,
6,	1.2529,	.9346,	.5890,	.0679,	.0106,	.0617,	.3830,	.1355,	.3313,	.3236,
7,	1.9681,	1.4038,	.5473,	.0444,	.3705,	.0856,	.8397,	.1954,	.3584,	.6120,
8,	1.7690,	1.3900,	.7820,	.1140,	.1630,	.2850,	.4890,	.3300,	.4090,	.5010,
+gp,	1.7690,	1.3900,	.7820,	.1140,	.1630,	.2850,	.4890,	.3300,	.4090,	.5010,
FBAR 2- 6,	1.4401,	1.3587,	.7307,	.0484,	.0608,	.2722,	.3329,	.2594,	.3333,	.4285,

Table 8	Fishing mortality (F) at age										
YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	FBAR 92-
AGE											
0,	.0835,	.0611,	.1610,	.1252,	.1318,	.0545,	.1042,	.2454,	.3700,	.2430,	.2861,
1,	.3744,	.3050,	.3629,	.5859,	.4276,	.4420,	.2846,	.3333,	.3241,	.2360,	.2978,
2,	.3964,	.4393,	.3913,	.3553,	.4083,	.3722,	.5723,	.5083,	.5200,	.4370,	.4884,
3,	.6600,	.5008,	.4982,	.4228,	.4134,	.3770,	.4570,	.5075,	.5167,	.4470,	.4904,
4,	.7169,	.5576,	.5828,	.5740,	.5600,	.4567,	.4844,	.5817,	.7287,	.5850,	.6318,
5,	.6435,	.5194,	.5937,	.6405,	.6345,	.4729,	.4653,	.5944,	.6957,	.5380,	.6094,
6,	.6967,	.6797,	.5903,	.6217,	.6779,	.4459,	.4439,	.6790,	.7895,	.6250,	.6978,
7,	.4951,	.7320,	.5407,	.5891,	.6325,	.5995,	.3582,	.6153,	.7390,	.5830,	.6458,
8,	.6990,	.6420,	.6290,	.7020,	.6630,	.5760,	.5400,	.6350,	.7460,	.5850,	.6553,
+gp,	.6990,	.6420,	.6290,	.7020,	.6630,	.5760,	.5400,	.6350,	.7460,	.5850,	
FBAR 2- 6,	.6227,	.5393,	.5313,	.5229,	.5388,	.4250,	.4846,	.5742,	.6501,	.5264,	

Traditional vpa using file input for terminal F

Table 10	Stock number at age (start of year)				Numbers*10**-5			
YEAR,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE								
0,	611061,	420249,	337520,	451574,	452443,	531628,	607851,	471468,
1,	174099,	224797,	154601,	124167,	166125,	166444,	195575,	222743,
2,	48487,	64047,	82678,	56875,	45678,	58437,	57055,	66035,
3,	29495,	31698,	45335,	57154,	37559,	28203,	31840,	31015,
4,	38133,	20406,	19907,	31317,	37448,	22140,	17907,	17069,
5,	29040,	28451,	15351,	14255,	22485,	21994,	14248,	11711,
6,	33687,	21283,	20041,	11169,	10146,	14372,	13721,	9232,
7,	18444,	23311,	14638,	11958,	7700,	6695,	8607,	7938,
8,	32619,	12600,	17292,	8871,	7685,	5619,	3821,	5154,
+gp,	35612,	33297,	26034,	18274,	8949,	13183,	8906,	8402,
TOTAL,	1050677,	880139,	733396,	785613,	796218,	868716,	959531,	850767,

cont'd.

Table 2.7.4 (continued)

Table 10	Stock number at age (start of year)					Numbers*10**-5				
YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
0,	504728,	285448,	1407818,	349408,	447137,	121153,	1088949,	463208,	476607,	628212,
1,	172173,	184723,	104452,	516289,	127975,	164493,	43440,	393226,	169580,	172760,
2,	73574,	51482,	58205,	29971,	165311,	37878,	46875,	14046,	132257,	55113,
3,	36210,	38092,	22398,	29159,	13484,	80595,	18368,	18769,	8108,	72773,
4,	15437,	20385,	20234,	11737,	14917,	6673,	48311,	10727,	8237,	5045,
5,	9845,	9428,	13554,	12207,	7568,	8785,	4464,	29914,	6531,	5951,
6,	7174,	5719,	6174,	9001,	6679,	4635,	6358,	2864,	16822,	5144,
7,	5233,	4297,	3334,	3623,	6751,	3686,	3123,	4255,	1391,	13040,
8,	3604,	3599,	2900,	1625,	2583,	4975,	2143,	2244,	2476,	1046,
+gp,	3488,	6483,	4471,	2571,	6861,	5493,	3349,	2256,	3006,	2294,
TOTAL,	831465,	609654,	1643541,	965591,	799267,	438365,	1265380,	941510,	825013,	961377,

Traditional vpa using file input for terminal F

Table 10	Stock number at age (start of year)					Numbers*10**-5				
YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	348994,	278544,	402602,	387005,	215851,	410890,	323335,	208664,	101592,	217522,
1,	228217,	127474,	100295,	144360,	137500,	78756,	145945,	114978,	72416,	35695,
2,	46689,	65650,	38967,	27386,	39335,	36399,	22161,	29411,	23739,	13583,
3,	27687,	15931,	26919,	18926,	5378,	13302,	10194,	6794,	9680,	6343,
4,	39457,	10847,	6425,	9873,	2386,	1766,	3070,	2478,	2497,	2096,
5,	3158,	16434,	5555,	2308,	3076,	902,	420,	817,	1009,	843,
6,	3972,	1485,	6468,	2214,	610,	985,	342,	127,	428,	353,
7,	3753,	2155,	914,	2145,	637,	84,	316,	25,	67,	99,
8,	9367,	2281,	1336,	189,	406,	174,	3,	35,	20,	26,
+gp,	1778,	5644,	2829,	1269,	372,	177,	330,	13,	9,	14,
TOTAL,	713071,	526445,	592310,	595676,	405551,	543435,	506118,	363342,	211457,	276575,

Table 10	Stock number at age (start of year)					Numbers*10**-5				
YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	29368,	27818,	43794,	46585,	105920,	166725,	377713,	644523,	617798,	534777,
1,	74260,	9288,	8863,	14628,	16384,	35833,	54061,	85671,	169397,	152356,
2,	8383,	13764,	2694,	2440,	4416,	5113,	11769,	14930,	25138,	48359,
3,	3601,	1707,	2708,	1615,	1766,	2980,	2649,	6300,	8510,	13740,
4,	1974,	659,	361,	570,	1270,	1356,	1616,	1657,	3097,	5023,
5,	708,	465,	108,	224,	468,	1054,	921,	1088,	1180,	1807,
6,	234,	105,	96,	32,	200,	404,	747,	563,	847,	819,
7,	109,	61,	37,	48,	27,	179,	343,	461,	445,	550,
8,	42,	14,	13,	19,	42,	17,	149,	134,	343,	281,
+gp,	17,	6,	0,	29,	7,	4,	30,	41,	377,	473,
TOTAL,	118699,	53884,	58677,	66192,	130501,	213664,	449999,	755368,	827132,	758186,

Table 10	Stock number at age (start of year)					Numbers*10**-5						
YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	GMST
AGE												
0,	819283,	973534,	843731,	415582,	378320,	370305,	365615,	713080,	491037,	306237,	0,	330
1,	158638,	277243,	336923,	264237,	134895,	121996,	129008,	121192,	205249,	124772,	88355,	112
2,	46099,	40134,	75178,	86226,	54108,	32360,	28848,	35705,	31947,	54604,	36252,	32
3,	26506,	22975,	19162,	37658,	44775,	26647,	16522,	12057,	15911,	14071,	26130,	14
4,	7465,	11216,	11400,	9533,	20202,	24246,	14964,	8565,	5943,	7771,	7368,	7
5,	2723,	3298,	5811,	5759,	4858,	10441,	13896,	8342,	4332,	2595,	3917,	3
6,	902,	1294,	1775,	2904,	2746,	2331,	5888,	7895,	4166,	1955,	1371,	20
7,	536,	406,	594,	890,	1411,	1262,	1350,	3418,	3623,	1711,	947,	10
8,	270,	296,	177,	313,	447,	678,	627,	854,	1671,	1565,	864,	5
+gp,	332,	322,	179,	174,	187,	282,	316,	523,	798,	1041,	1314,	
TOTAL,	1062752,	1330719,	1294931,	823278,	641949,	590549,	577032,	911630,	764676,	516321,	166518,	

cont'd.

Table 2.7.4 (continued)

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1947,	61106048,	8225109,	4939302,	586600,	.1188,	.1931,
1948,	42024944,	7183683,	4064810,	502100,	.1235,	.2040,
1949,	33751952,	6551569,	3751413,	508500,	.1355,	.2215,
1950,	45157460,	5794995,	3269583,	491700,	.1504,	.2162,
1951,	45244252,	5316776,	2618719,	600400,	.2293,	.3212,
1952,	53162816,	5262297,	2406569,	664400,	.2761,	.3374,
1953,	60785120,	5140106,	2087927,	698500,	.3345,	.3678,
1954,	47146824,	4996976,	1901795,	762900,	.4011,	.4213,
1955,	50472776,	4588597,	1806215,	806400,	.4465,	.3963,
1956,	28544782,	4140687,	1876701,	675200,	.3598,	.4072,
1957,	140781856,	5228528,	1746530,	682900,	.3910,	.3970,
1958,	34940780,	5155570,	1397309,	670500,	.4799,	.3997,
1959,	44713732,	5317878,	2601470,	784500,	.3016,	.4472,
1960,	12115316,	4018935,	2133604,	696200,	.3263,	.3111,
1961,	108894912,	4543627,	1830966,	696700,	.3805,	.3956,
1962,	46320808,	4529123,	1239819,	627800,	.5064,	.4734,
1963,	47660696,	4779593,	2329719,	716000,	.3073,	.2181,
1964,	62821148,	4911398,	2138496,	871200,	.4074,	.3378,
1965,	34899436,	4425268,	1527896,	1168800,	.7650,	.6908,
1966,	27854342,	3356653,	1319586,	895500,	.6786,	.6172,
1967,	40260220,	2823796,	929250,	695500,	.7485,	.7945,
1968,	38700512,	2526668,	418661,	717800,	1.7145,	1.3284,
1969,	21585082,	1908185,	427025,	546700,	1.2803,	1.0982,
1970,	41088944,	1924545,	377232,	563100,	1.4927,	1.0965,
1971,	32333526,	1856632,	272900,	520100,	1.9058,	1.3903,
1972,	20866444,	1551299,	289419,	497500,	1.7190,	.6981,
1973,	10159176,	1157942,	234254,	484000,	2.0661,	1.1293,
1974,	21752208,	914754,	162864,	275100,	1.6891,	1.0462,
1975,	2936825,	685172,	83634,	312800,	3.7401,	1.4401,
1976,	2781771,	364525,	80717,	174800,	2.1656,	1.3587,
1977,	4379430,	217239,	51749,	46000,	.8889,	.7307,
1978,	4658474,	232949,	70205,	11000,	.1567,	.0484,
1979,	10592048,	389624,	112885,	25100,	.2224,	.0608,
1980,	16672470,	636787,	137382,	70764,	.5151,	.2722,
1981,	37771304,	1163266,	202160,	174879,	.8651,	.3329,
1982,	64452256,	1842047,	283470,	275079,	.9704,	.2594,
1983,	61779784,	2478699,	438299,	387202,	.8834,	.3333,
1984,	53477732,	2788058,	725827,	409489,	.5642,	.4285,
1985,	81928272,	3210353,	747967,	609108,	.8144,	.6227,
1986,	97353376,	4171588,	797778,	660553,	.8280,	.5393,
1987,	84373040,	3977258,	912496,	773411,	.8476,	.5313,
1988,	41558204,	3553274,	1098295,	875923,	.7975,	.5229,
1989,	37831992,	3385369,	1301950,	768886,	.5906,	.5388,
1990,	37030580,	3207970,	1138775,	619963,	.5444,	.4250,
1991,	36561436,	3125061,	970395,	635929,	.6553,	.4846,
1992,	71307984,	3002230,	756654,	694206,	.9175,	.5742,
1993,	49103660,	3023160,	483888,	656000,	1.3557,	.6501,
1994,	30623668,	2548330,	762184,	600000,	.7872,	.5264,
Arith.						
Mean	43381668,	3377795,	1276182,	566410,	.8093,	.5549,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 2.8.1 Computation of reference Fs for catch prediction of North Sea Herring

Age	North Sea Catches			Div.III a Catches				Total Stock	Total Catch
	Fleet A	Fleet B	Total N.S.	Fleet C	Fleet D	Fleet E	Total IIIa		
0	1.65	3715.65	3717.30	18.09	149.40	374.74	542.23		4259.53
1	168.25	282.25	450.50	331.54	358.97	549.14	1239.65		1690.15
2	1357.60	25.52	1383.12	139.21	53.78	112.20	305.19	1688.31	1688.31
3	457.63	5.48	463.11				0.00		463.11
4	326.49	2.58	329.07	0.00	0.00		0.00		329.07
5	99.29	3.91	103.20		0.00	0.00	0.00		103.20
6	86.82	0.11	86.93	0.00	0.00	0.00	0.00		86.93
7	71.57	0.65	72.22	0.00	0.00	0.00	0.00		72.22
8	110.58	0.21	110.79	0.00	0.00	0.00	0.00		110.79
9			0.00	0.00	0.00	0.00	0.00		0.00

$$N(1.\text{Dec}) - (N(1.\text{Jan}) \cdot \exp(-M/2) - C) \cdot \exp(-M/2)$$

Age	M	exp(-M/2)	Total Stock N	Split factors		Stock N 1. Jan		Stock N 31. Dec.		F N.S.	F III a
				N.S.	IIIa	N.S.	III a	N.S.	III a		
0	1.00	0.6065	37600.0	0.75	0.25	28200.0	9400.0	8119.5	3129.2	0.2450	0.0999
1	1.00	0.6065	16400.0	0.74	0.26	12136.0	4264.0	4191.3	816.8	0.0632	0.6526
2	0.50	0.7788	5093.2	1.00	1.00	5093.2	5093.2				

$$F = \ln(N(1.\text{Jan})/N(31.\text{Dec})) - M$$

Age	North Sea Catches			III a Catches			
	Fleet A	Fleet B	Total N.S.	Fleet C	Fleet D	Fleet E	Total IIIa
0	0.000	0.245	0.245	0.003	0.028	0.069	0.100
1	0.024	0.040	0.063	0.175	0.189	0.289	0.653
2	0.351	0.007	0.437	0.036	0.014	0.029	
3	0.442	0.005	0.447				
4	0.581	0.005	0.585				
5	0.518	0.020	0.538				
6	0.624	0.001	0.625				
7	0.578	0.005	0.583				
8	0.584	0.001	0.585				

Age group 2 is the total F (from ICA) distributed on all 5 fleets

These are the Fs from ICA, including age gr 2

	A	B	C	D	E	F	G	H	I	J	
1	SHEET 2 (NSHER94)										
2	NORTH SEA HERRING SHORT TERM PREDICTION PROGRAM, WG						1995				
3	Fleet	Description	The prediction is based on the following assumptions:								
4	A:	IV HC	North Sea Human Consumption		Age group 0 : Some migrate to IIIa, depending on year class						
5	B:	IV IND	North Sea Industrial		Age group 1 : Some migrate to IIIa, depending on year class						
6	C:	IIIa HC	IIIa Human consumption		Age group 2: All fish in III a migrates back to the North Sea						
7	D:	IIIa MC	IIIa "Mixed Clupeid"		during the year						
8	E:	IIIa IND.	IIIa Industrial		Age groups >3: Only in North Sea						
9	F:	Fl. 22 + 24	Western Baltic Combined fisheries								
10							Migration takes place 1 January				
11							(distribution from MIK)				
12							(distribution from IBTS)				
13							(Total "area-mixing" assumed)				
14	INPUT DATA (indicated with Bold Italic)						(No area-mixing assumed)				
15	Comments with Italic										
16	1995						0				
17	Table 1 1995										
18	NORTH SEA HERRING STOCK SIZE 1. JANUARY										
19		STOCK	MEAN WEIGHT AT		MATURITY	NATURAL					
20		NUMBER	AGE IN THE STOCK		OGIVE	MORTALITY					
21		Input	Input	Input	Input	Input					
22	AGE		SPAW.	1. JAN.		M	M/2	exp(-M/2)			
23	0	48800.0	8	8	0.00	1.00	0.50	0.6065			
24	1	11700.0	68	68	0.00	1.00	0.50	0.6065			
25	2	5862.0	138	138	0.60	0.30	0.15	0.8607			
26	3	1471.0	191	191	0.89	0.20	0.10	0.9048			
27	4	742.0	206	206	1.00	0.10	0.05	0.9512			
28	5	273.0	239	239	1.00	0.10	0.05	0.9512			
29	6	197.0	270	270	1.00	0.10	0.05	0.9512			
30	7	178.0	287	287	1.00	0.10	0.05	0.9512			
31	8	158.0	310	310	1.00	0.10	0.05	0.9512			
32	9+	100.0	329	329	1.00	0.10	0.05	0.9512			
33	TOTAL	69481.0							0.9512		
34											
35	Table 2										
36	NORTH SEA HERRING. MEAN WEIGHT AT AGE IN THE CATCH BY FLEET										
37											
38		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24				
39	AGE	A	B	C	D	E	F				
40	0	7	6.1	27.6	20.9	14.2	0				
41	1	84.06	39.5	86	17.4	32.7	0				
42	2	130.16	98.2	92.5	50.1	71.6	0				
43	3	159.58	115.9	0	0	0	0				
44	4	180.64	161.4	0	0	0	0				
45	5	214.96	195.5	0	0	0	0				
46	6	240.49	238.6	0	0	0	0				
47	7	255.88	190.9	0	0	0	0				
48	8	276.35	239.5	0	0	0	0				
49	9+	276	239.7	0	0	0	0				
50											
51	Table 3 (ALL INPUT)										
52	FISHING MORTALITY BY FLEET RELATIVE TO AREA *)										
53		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24				
54	AGE	A	B	C	D	E	F				
55	0	0.0000	0.2450	0.0030	0.0280	0.0690	0				
56	1	0.0240	0.0400	0.1750	0.1890	0.2890	0				
57	2	0.3510	0.0070	0.0040	0.0100	0.0300	0				
58	3	0.4420	0.0050	0	0	0	0				
59	4	0.5810	0.0050	0	0	0	0				
60	5	0.5180	0.0200	0	0	0	0				
61	6	0.6240	0.0010	0	0	0	0				
62	7	0.5700	0.0050	0	0	0	0				
63	8	0.5840	0.0010	0	0	0	0				
64	9	0.5840	0.001	0	0	0	0				
65) These are "area-mortalities", NOT traditional fishing mortalities										
66											
67	Table 2.8.2. EXCEL 5 "work book" for short term prediction of North Sea Herring (Sheet NSHER94)										

Table 2.8.3 EXCEL 5 "work book" for short-term prediction of North Sea herring.

NORTH SEA HERRING SHORT TERM PREDICTION PROGRAM, WG
SUMMARY OF CALCULATIONS

1995

Fleet	Description
A:	IV HC North Sea Human Consumption
B:	IV IND North Sea Industrial
C:	IIIa HC IIIa Human consumption
D:	IIIa MC IIIa "Mixed Clupeid"
E:	IIIa IND. IIIa Industrial
F:	Fl. 22+24 Western Baltic Combined fisheries

Table 1 1995

1995 NORTH SEA HERRING. F-FACTORS								
	IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24	A + B	C+D+E+F
TOTAL a)	A	B	C	D	E	F	IV	IIIa
F-Factor	1	1	1	1	1	0	1	1
(Total Factor) * (F-Factor)	1	1	1	1	1	0		

Input to sheet 2 (NSHER94)

Table 2 SUMMARY RESULTS FOR YEAR 1995

Table 2		SUMMARY RESULTS FOR YEAR 1999							
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24	A + B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	10223	2767	5444	332	562	1119	0	8211	2012
YIELD	545527	428002	44727	27400	12099	33298	0	472730	72797
SSB*.001	718	AVG F 2-6		0.526					

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Table 3 1996

1996 NORTH SEA HERRING. F-FACTORS								
	IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24	A + B	C+D+E+F
TOTAL	A	B	C	D	E	F	IV	IIIa
F-Factor	1	1	1	1	1	0	1	1
(Total Factor) * (F-Factor)	1	1	1	1	1	0		

0.5556

Input to sheet 2 (NSHER94)

Table 4 SUMMARY RESULTS FOR YEAR 1996

Table 4 SUMMARY RESULTS FOR YEAR 1999									
		IV HC	IV IND	IIIa HC	IIIa MC	IIIa IND.	Fl. 22 + 24	A + B	C+D+E+F
	TOTAL	A	B	C	D	E	F	IV	IIIa
CATCH	10458	2853	5075	502	718	1311	0	7928	2531
YIELD	582206	440842	46894	42098	14123	38250	0	487736	94471
SSB*.001	690	AVG F 2-6		0.579					

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BIOMASS AT 1st JANUARY	1997	2215754
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The "TABLE" option from menu "DATA"

Factor	Input variable: - Factor of Fleet A (other fleets kept constant)						
	Yield A	Yield B	Yield C	Yield D	Yield E	SSB	Avg.F
0.0	0	48144	42098	14123	38250	960	0.0571
0.2	103829	47867	42098	14123	38250	900	0.1604
0.4	199089	47604	42098	14123	38250	842	0.2641
0.5556	267774	47409	42098	14123	38250	800	0.3451
0.6	286556	47355	42098	14123	38250	788	0.3683
0.8	366928	47119	42098	14123	38250	738	0.4731
1.0	440842	46894	42098	14123	38250	690	0.5786
1.2	508872	46680	42098	14123	38250	645	0.6849
1.8	682653	46097	42098	14123	38250	524	1.0093
2.0	731915	45921	42098	14123	38250	489	1.1198
2.2	777465	45752	42098	14123	38250	455	1.2318

Table 2.8.4 EXCEL 5 "work book" for short-term prediction of North Sea herring.

The "TABLE" option from menu "DATA"

Factor	Input: Factor of Fleet C and E (other fleets kept constant)						
	Yield A	Yield B	Yield C	Yield D	Yield E	SSB	Avg.F
0.0	440842	46894	55893	17319	47289	689.620	0.57894
0.2	440842	46894	52660	16576	45182	689.653	0.57888
0.4	440842	46894	49687	15889	43239	689.686	0.57882
0.6	440842	46894	46949	15255	41444	689.720	0.57876
0.8	440842	46894	44426	14668	39785	689.753	0.57870
1.0	440842	46894	42098	14123	38250	689.785	0.57864
1.2	440842	46894	39948	13618	36826	689.818	0.57858
1.4	440842	46894	37960	13149	35505	689.850	0.57852
1.6	440842	46894	36119	12713	34278	689.883	0.57846
1.8	440842	46894	34414	12306	33136	689.915	0.57840
2.0	440842	46894	32833	11927	32073	689.946	0.57834

The "TABLE" option from menu "DATA"

Factor	Input variable: Factor of Fleet B (other fleets kept constant)						
	Yield A	Yield B	Yield C	Yield D	Yield E	SSB	Avg.F
0.00	442488	0	42098	14123	38250	693	0.5706
0.20	442157	9898	42098	14123	38250	692	0.5722
0.40	441827	19525	42098	14123	38250	692	0.5738
0.60	441498	28894	42098	14123	38250	691	0.5754
0.80	441170	38013	42098	14123	38250	690	0.5770
1.00	440842	46894	42098	14123	38250	690	0.5786
1.20	440515	55545	42098	14123	38250	689	0.5802
1.40	440189	63976	42098	14123	38250	689	0.5818
1.60	439863	72196	42098	14123	38250	688	0.5834
1.80	439538	80213	42098	14123	38250	687	0.5851
2.00	439214	88035	42098	14123	38250	687	0.5867
2.20	438891	95669	42098	14123	38250	686	0.5883
2.40	438568	103124	42098	14123	38250	685	0.5899
2.60	438246	110405	42098	14123	38250	685	0.5915
2.80	437925	117520	42098	14123	38250	684	0.5931
3.00	437605	124474	42098	14123	38250	683	0.5947
3.20	437285	131275	42098	14123	38250	683	0.5963
3.40	436966	137927	42098	14123	38250	682	0.5979
3.60	436648	144437	42098	14123	38250	682	0.5995
3.80	436330	150810	42098	14123	38250	681	0.6011
4.00	436013	157050	42098	14123	38250	680	0.6027

Table 2.11.1 Herring total North Sea, 1994.

Numbers (millions) and weights (g) at age (winter rings) per year class of herring caught in each quarter. Spring spawners transferred to Division IIIa, and North Sea autumn spawners caught in Division IIIa are not included.

Quarter		Winter ring										Total 1983 (numbers)	SOP (‘000t)
		0 1992	1 1991	2 1990	3 1989	4 1988	5 1987	6 1986	7 1985	8 1984	9 1983		
I	No	0.0	97.6	143.8	42.7	53.7	9.1	9.4	11.8	9.1	6.6	383.8	
	W		15	97	113	120	170	188	207	219	206		35.8
II	No	91.5	56.6	453.3	116.3	47.3	25.3	14.9	11.2	8.9	2.0	827.4	
	W	2	39	124	150	166	199	214	219	235	259		97.2
III	No	3041.3	227.0	520.4	188.3	86.2	49.8	37.1	32.0	36.4	24.4	4242.9	
	W	5	72	137	167	196	225	248	282	295	308		198.6
IV	No	584.5	69.3	274.4	144.0	158.2	30.0	34.1	20.6	15.1	11.8	1342.0	
	W	13	76	142	171	198	223	258	261	272	273		136.0
Total	No	3717.3	450.5	1391.9	491.3	345.4	114.2	95.5	75.7	69.5	44.8	6796.1	
	W	6	56	130	159	181	214	240	255	273	281		467.6

The stocks weights shown below are derived from acoustic survey samples taken in July from Divisions IVa,b and used in the SSVPA

	0 1993	1 1992	2 1991	3 1990	4 1989	5 1988	6 1987	7 1986	8 1985	9 1984
Stock weights		60	138	209	220	251	289	315	323	346

For the 2 and 3 ringers, the stocks weights shown below are for combined immature and mature fish.
4 ringers and older were 100% mature

	Mean weight
2 immature	113
2 mature	155
3 immature	138
3 mature	216

Chart1

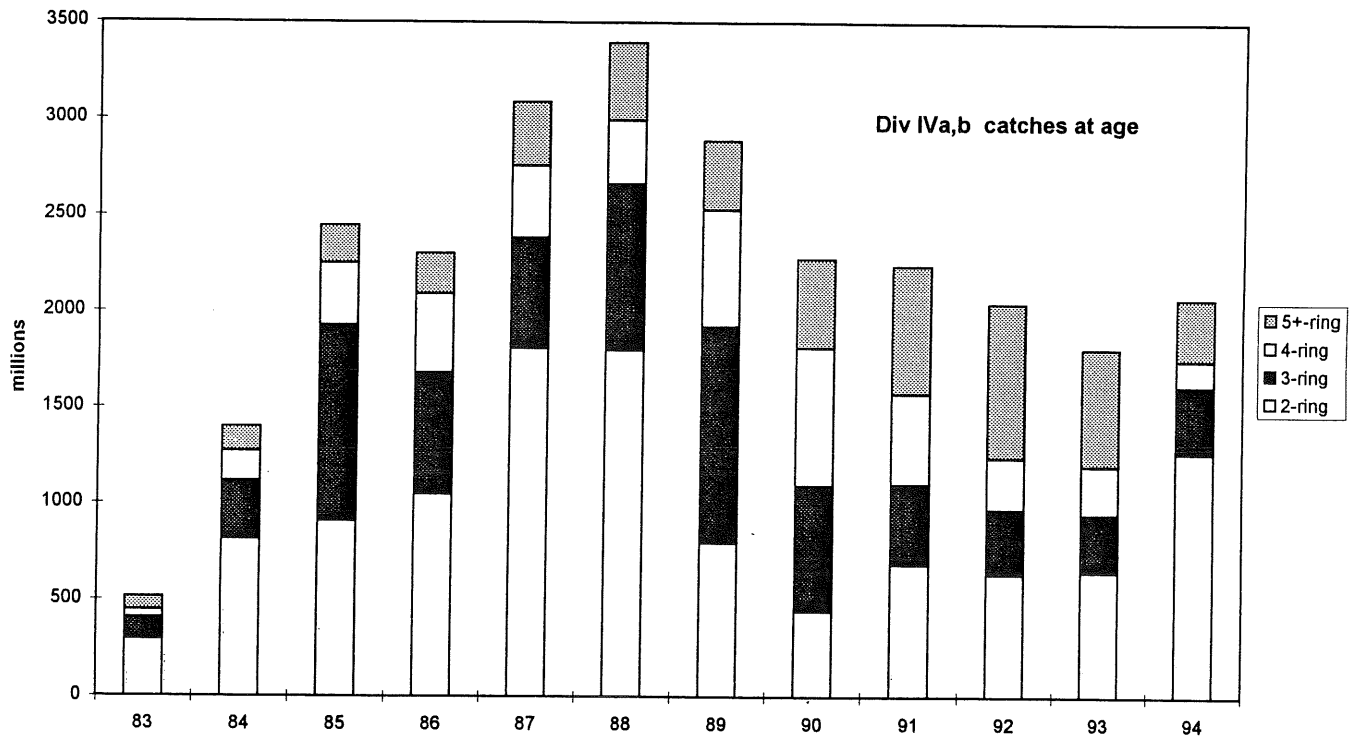


Figure 2.2.1

Chart1

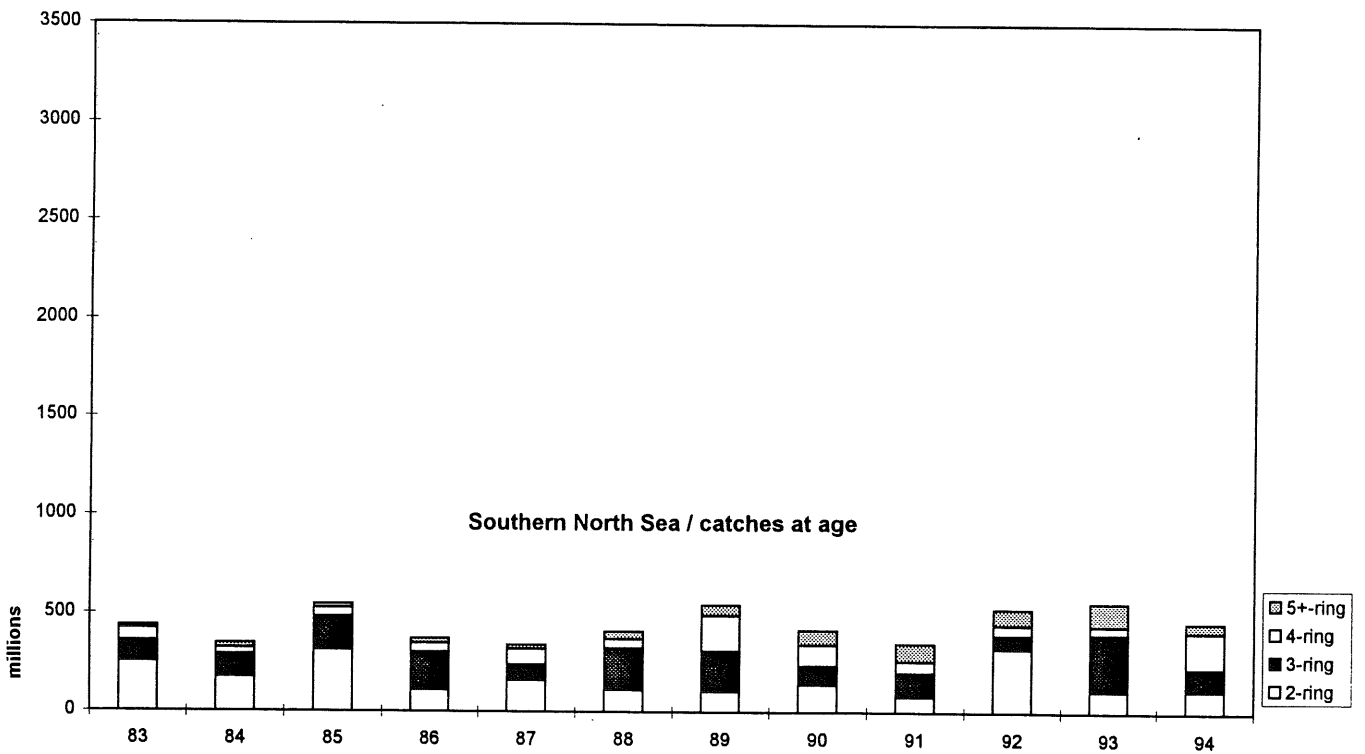
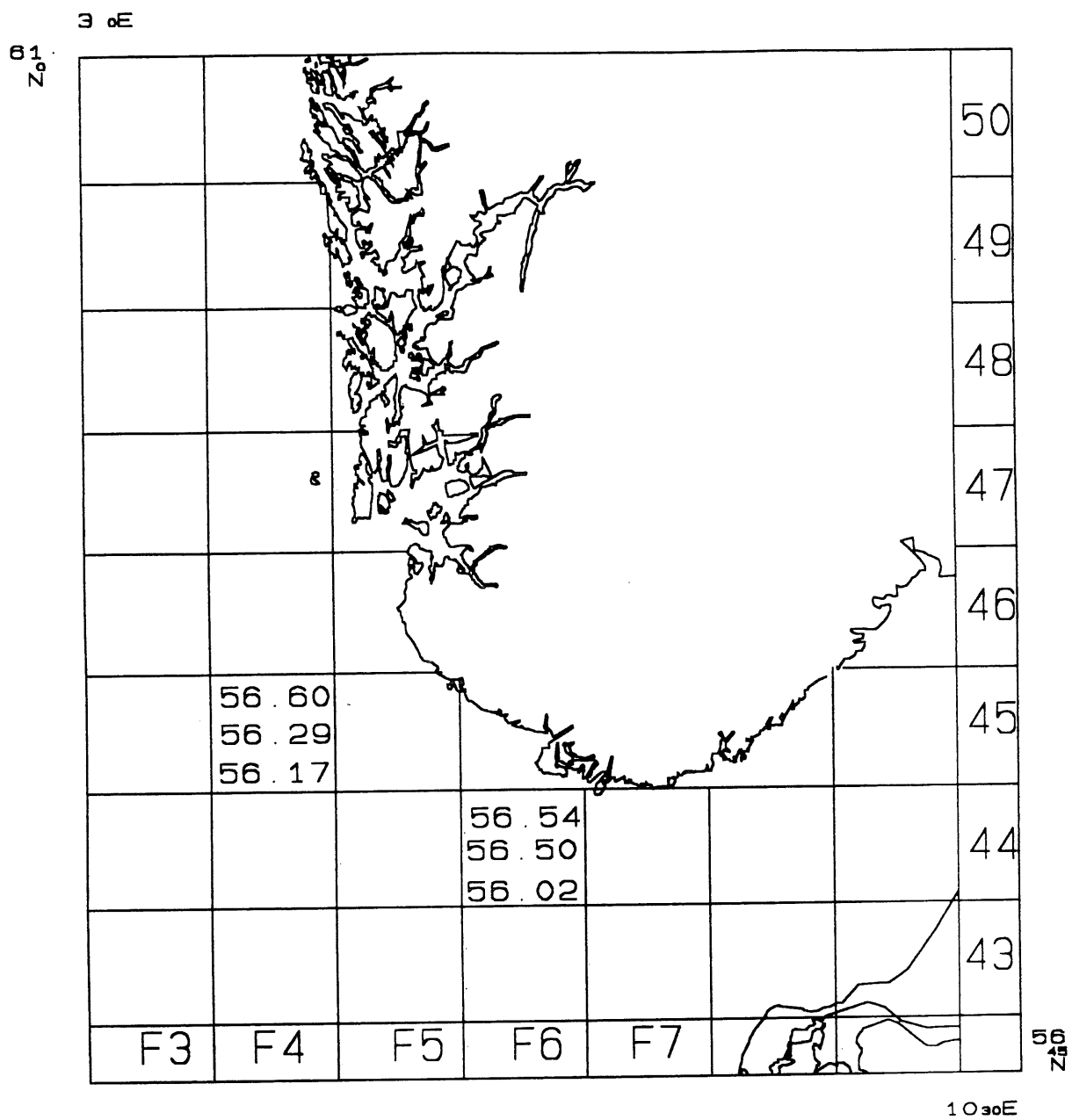
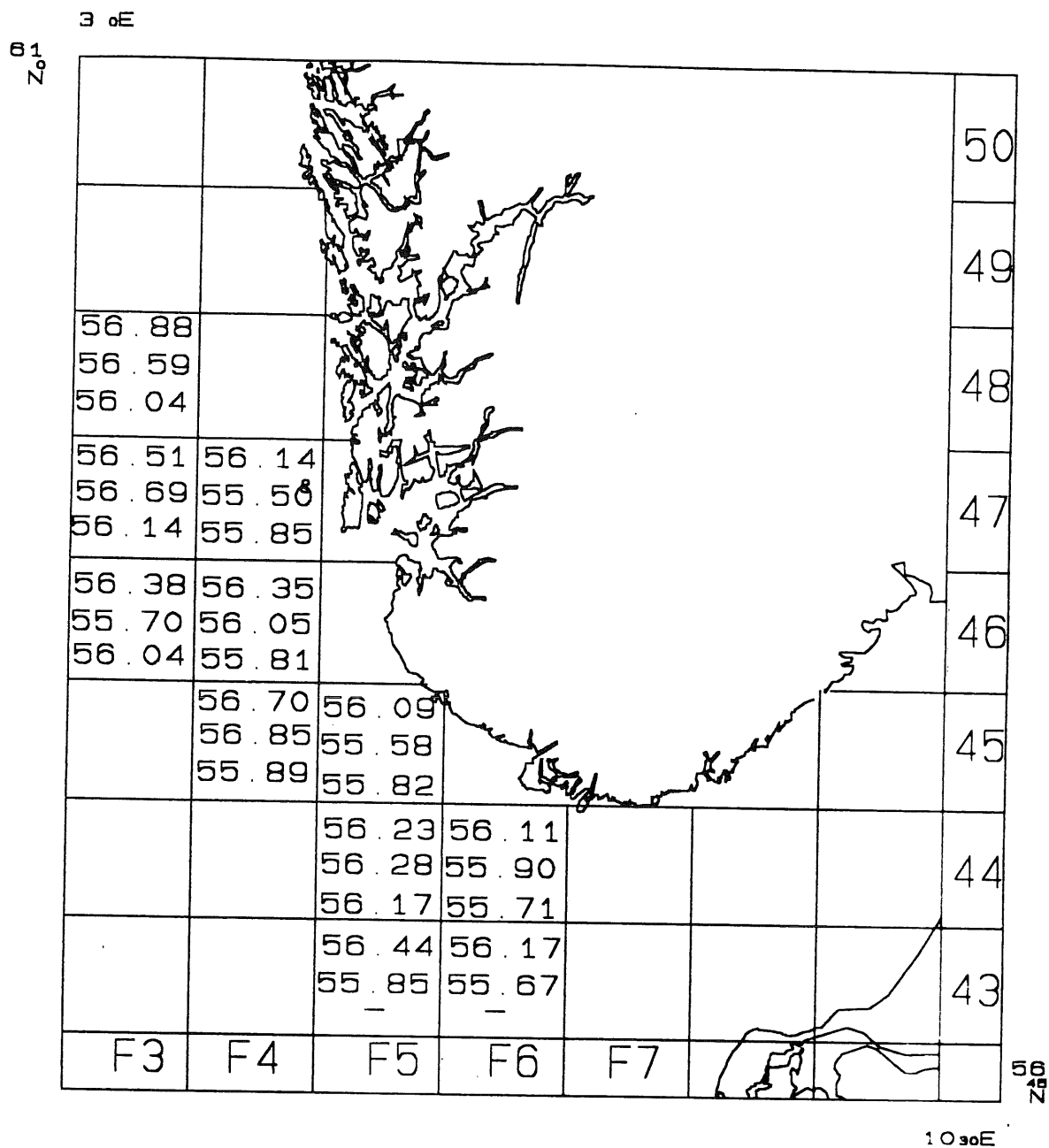


Figure 2.2.2



Age	Mean VS	Percentage of Spring Spawners
2	56.6	0
3	56.4	15
4+	56.1	58

Figure 2.2.3 Mean vertebral counts of 2, 3 and 4-ring herring. May 1994.



Age	Mean VS	Percentage of Spring Spawners
2	56.4	14
3	56.6	76
4+	55.9	80

Figure 2.2.4 Mean vertebral counts of 2, 3 and 4-ring herring. July 1994.

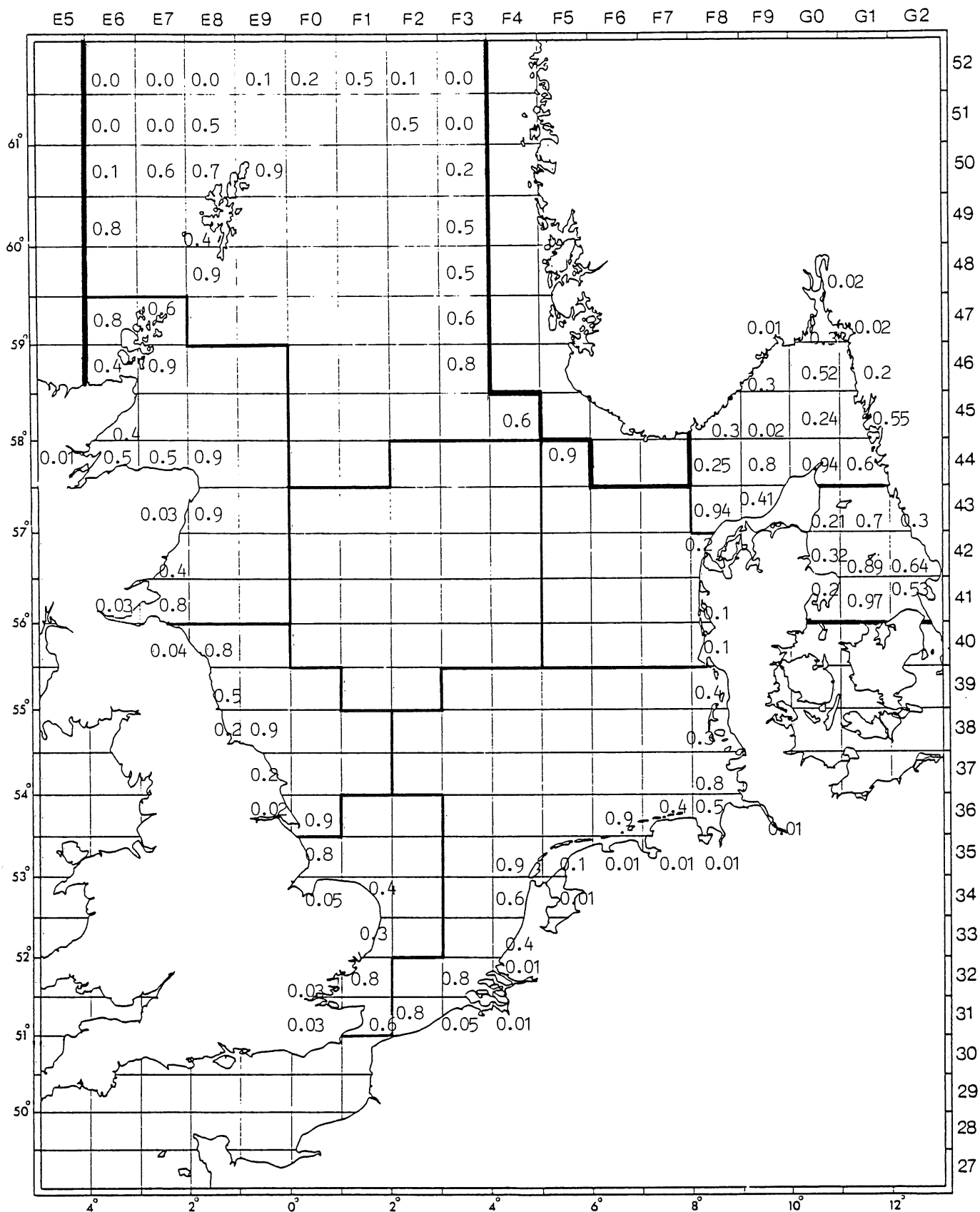


Figure 2.3.1 Weighting factors used in the revised procedure of calculating the IBTS index. Numbers indicate the relative weight of estimates in a given rectangle

Relative changes in the 0-ringer and 1-ringer indices

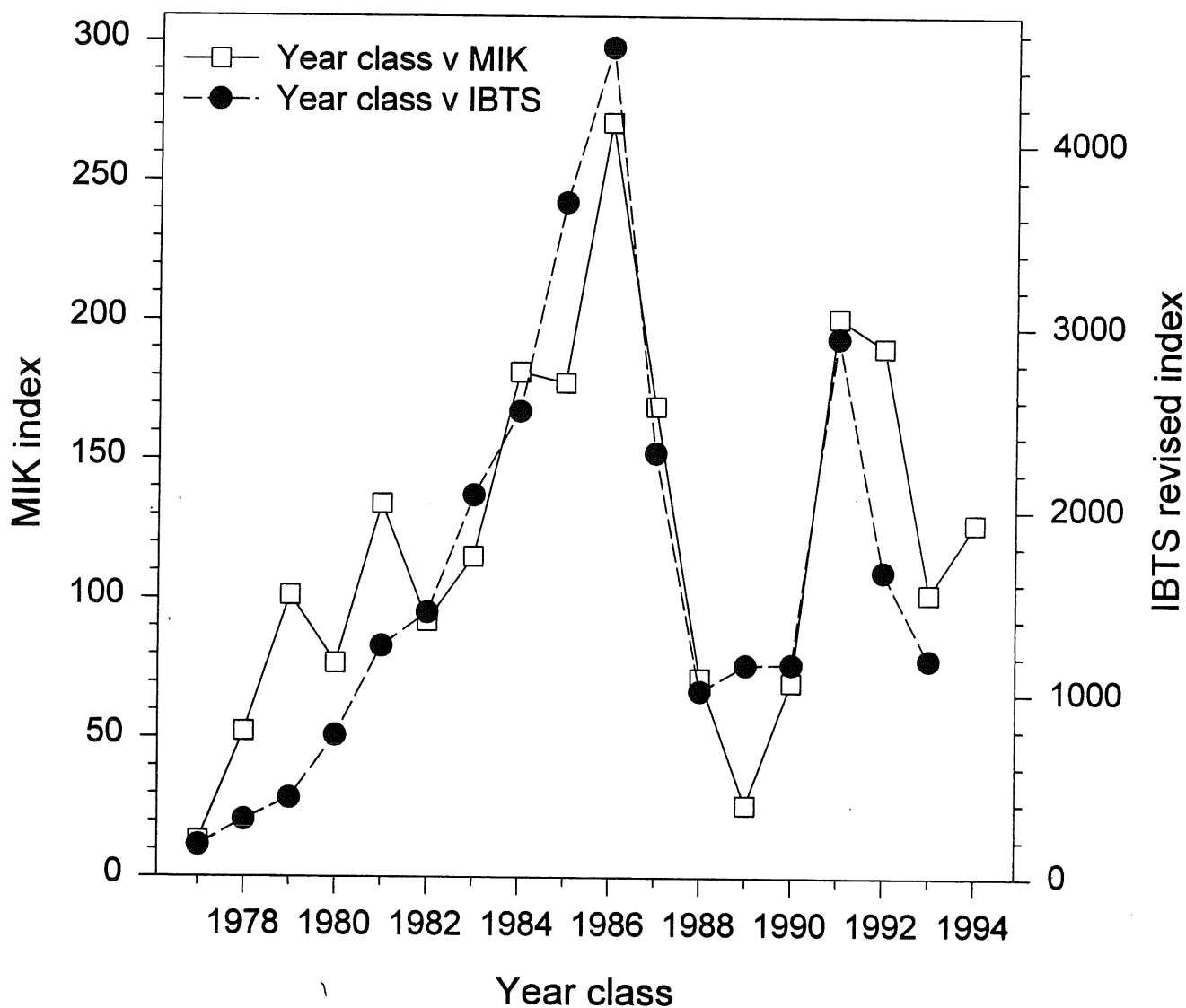
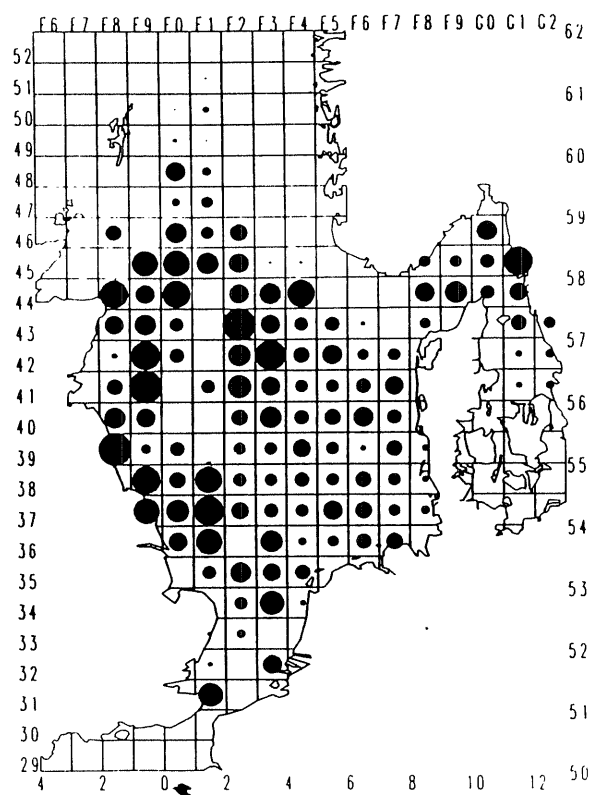
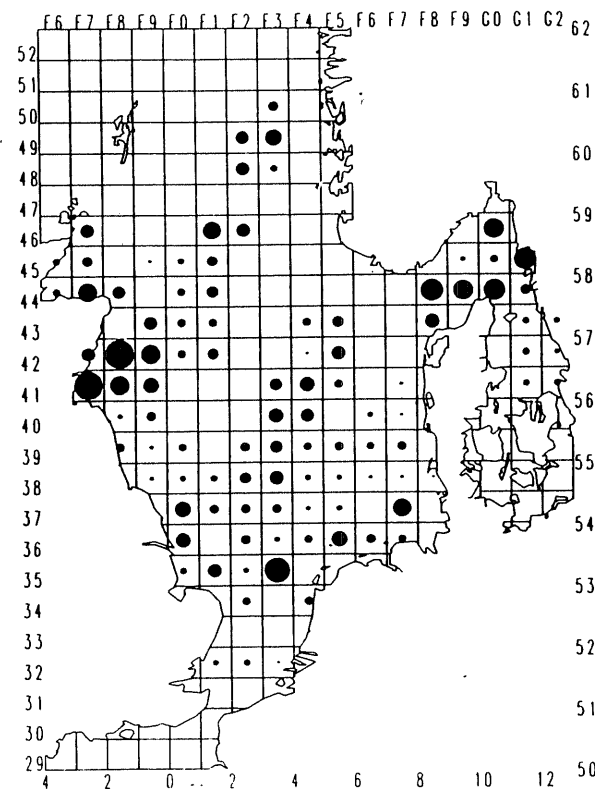


Figure 2.3.2 Trend in MIK 0-ringer and IBTS 1-ringer indices for the year classes 1977-1994.

0-ringers year class 1992



0-ringers year class 1993



0-ringers year class 1994

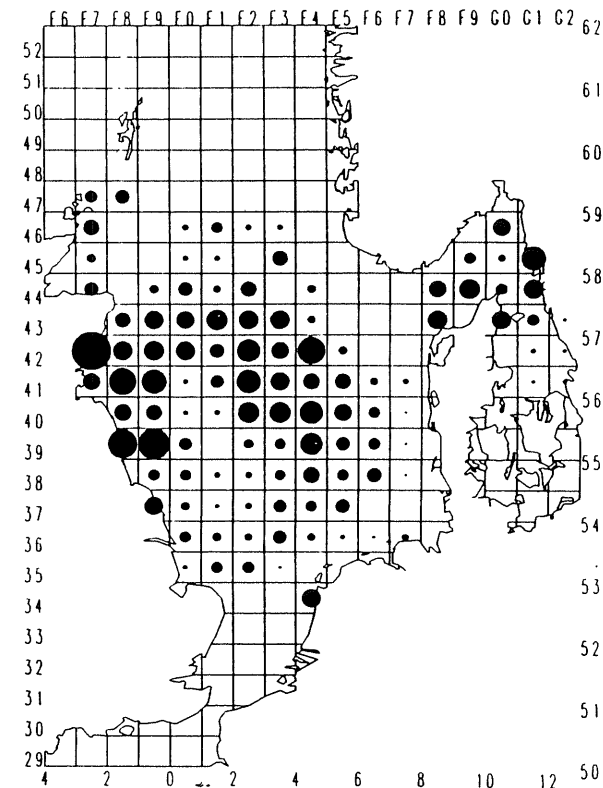


Figure 2.3.3 Distribution of 0-ringers, year classes 1992-1994, Density of 0-ringers within statistical rectangles estimated from catches by the MIK ring-net during IBTS in February. Areas of filled circles illustrate densities in no m^{-2} ; the area of a circle extending to the border of a rectangle represents 1.8 m^{-2} .

1-ringer index versus 0-ringer index of same yearclasses

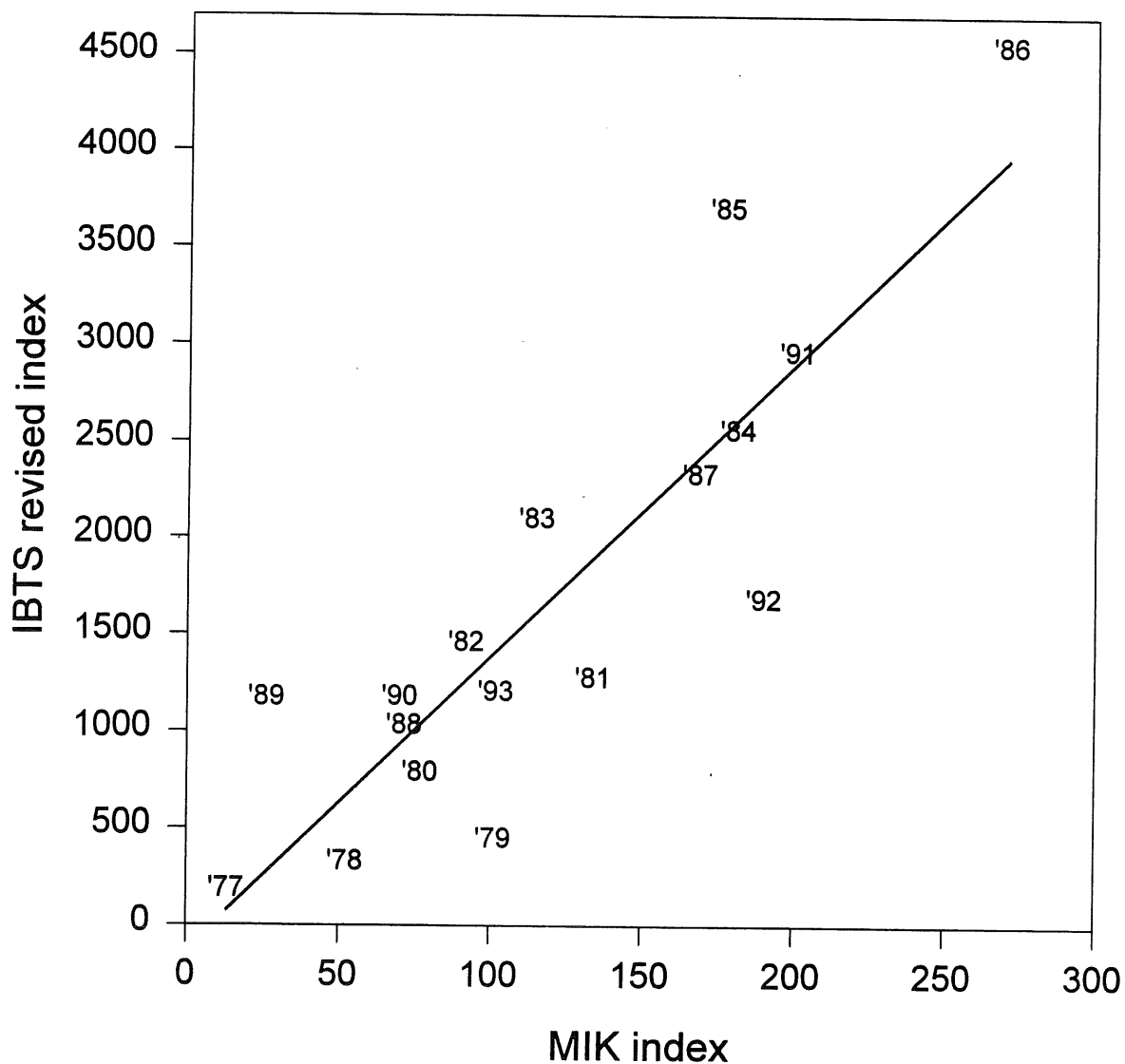


Figure 2.3.4 The relationship between the two indices of recruitment. The numbers in the figure refer to the given year class of herring. The regression line has a r-square of 0.76.

Trend in recruitment of 1-ringers

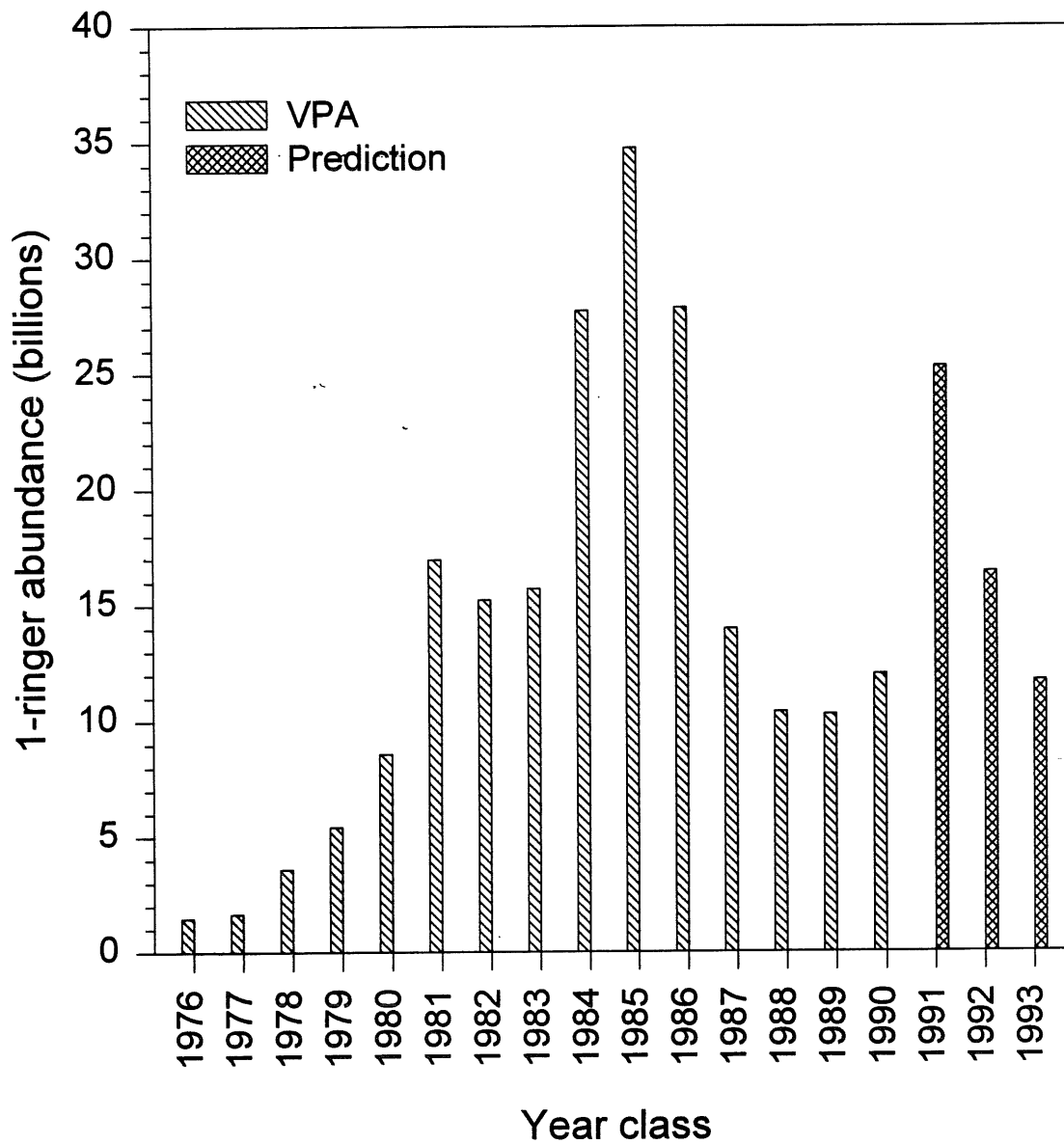
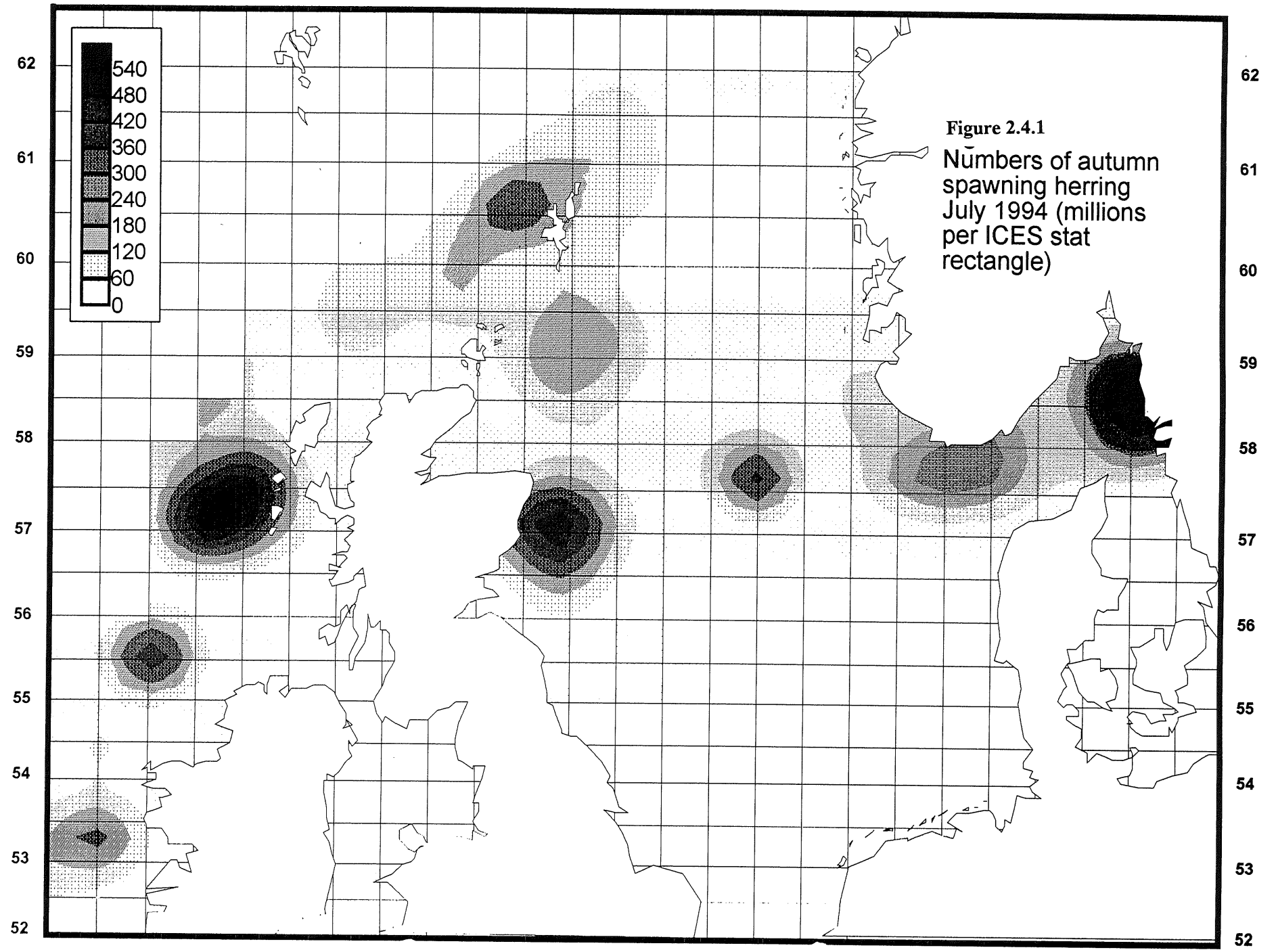


Figure 2.3.5 The trend in recruitment of year classes 1976 to 1990 as calculated by the VPA (using ICA procedures). The RCT3 predictions of recruitment are shown by additional bars for the year classes 1991 to 1993.



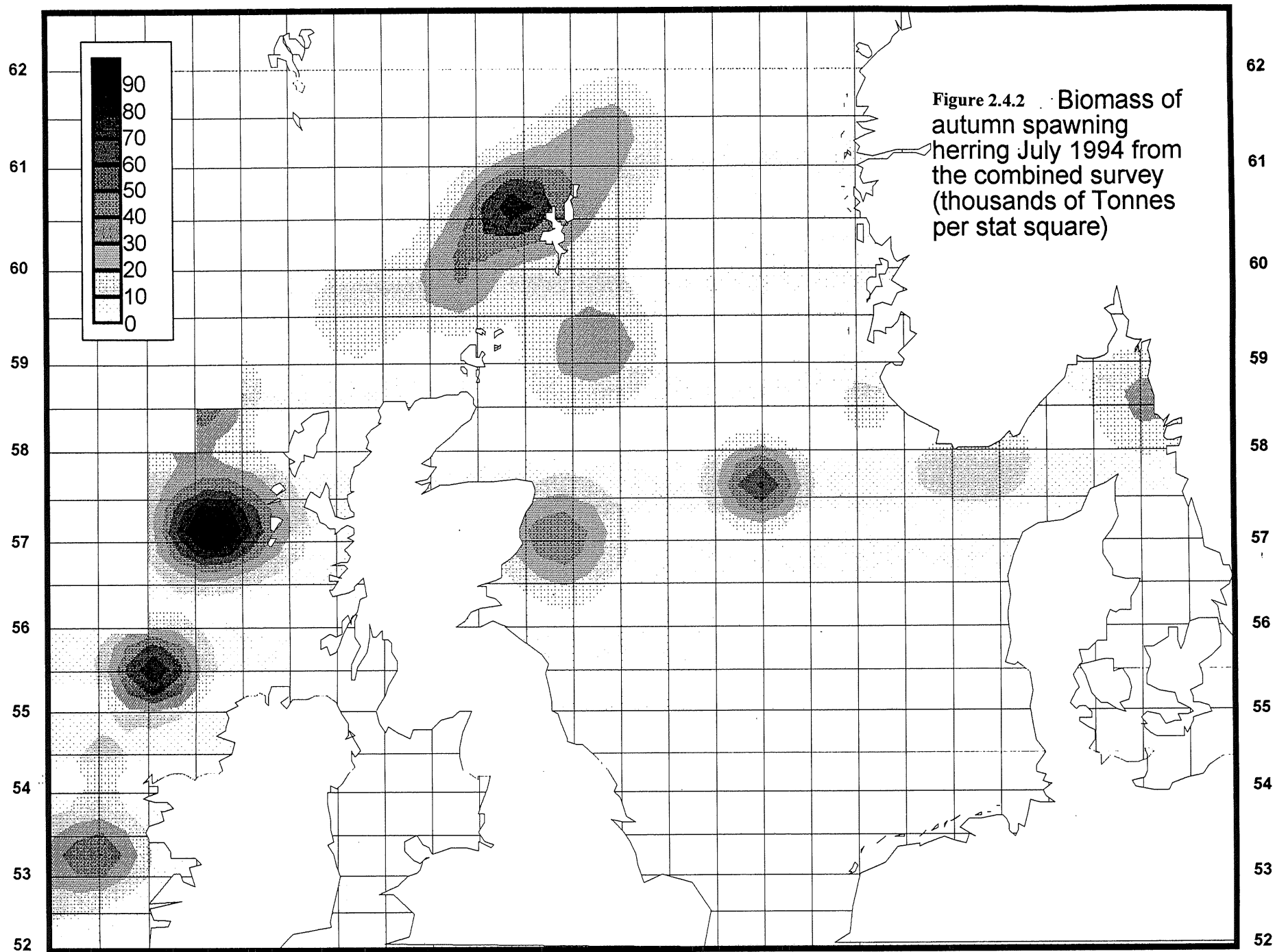
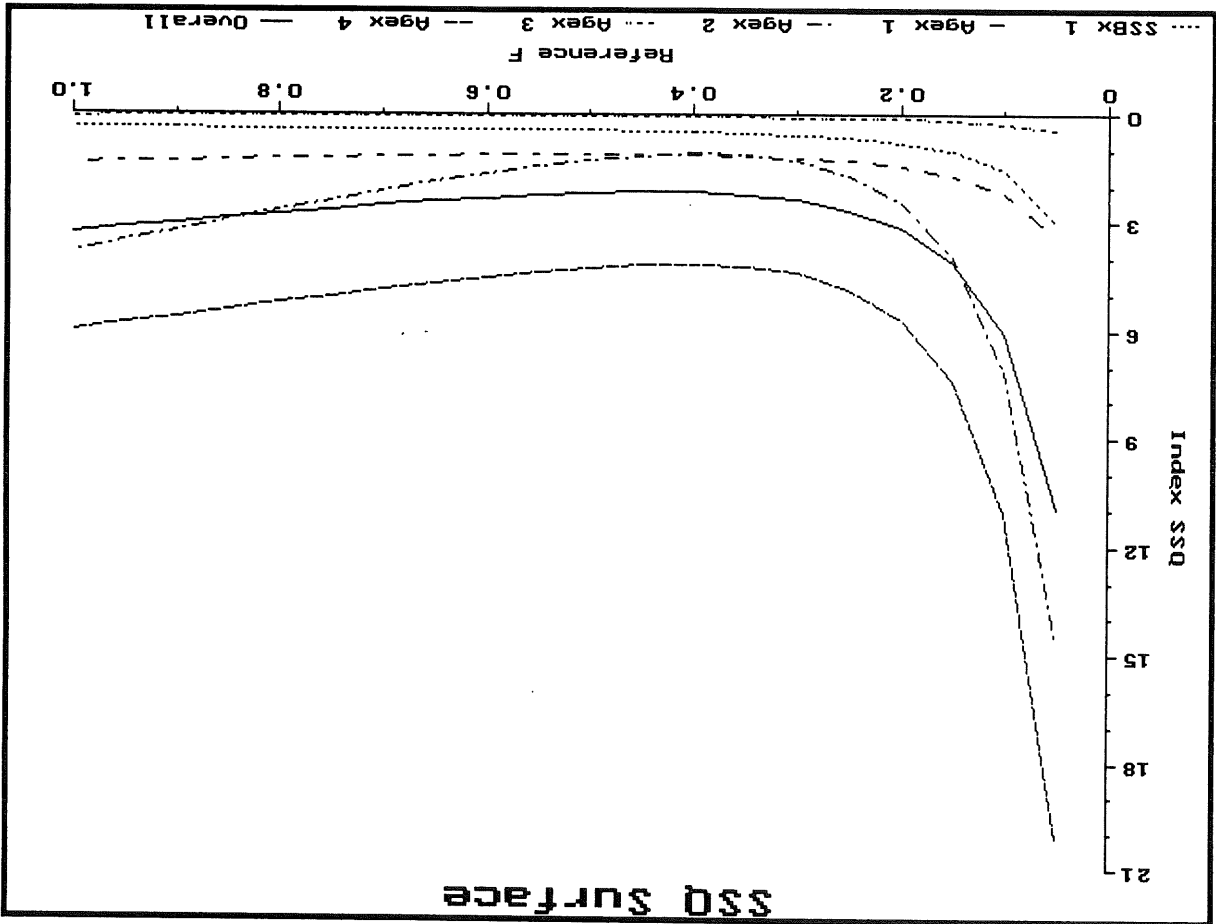


Figure 2.7.1



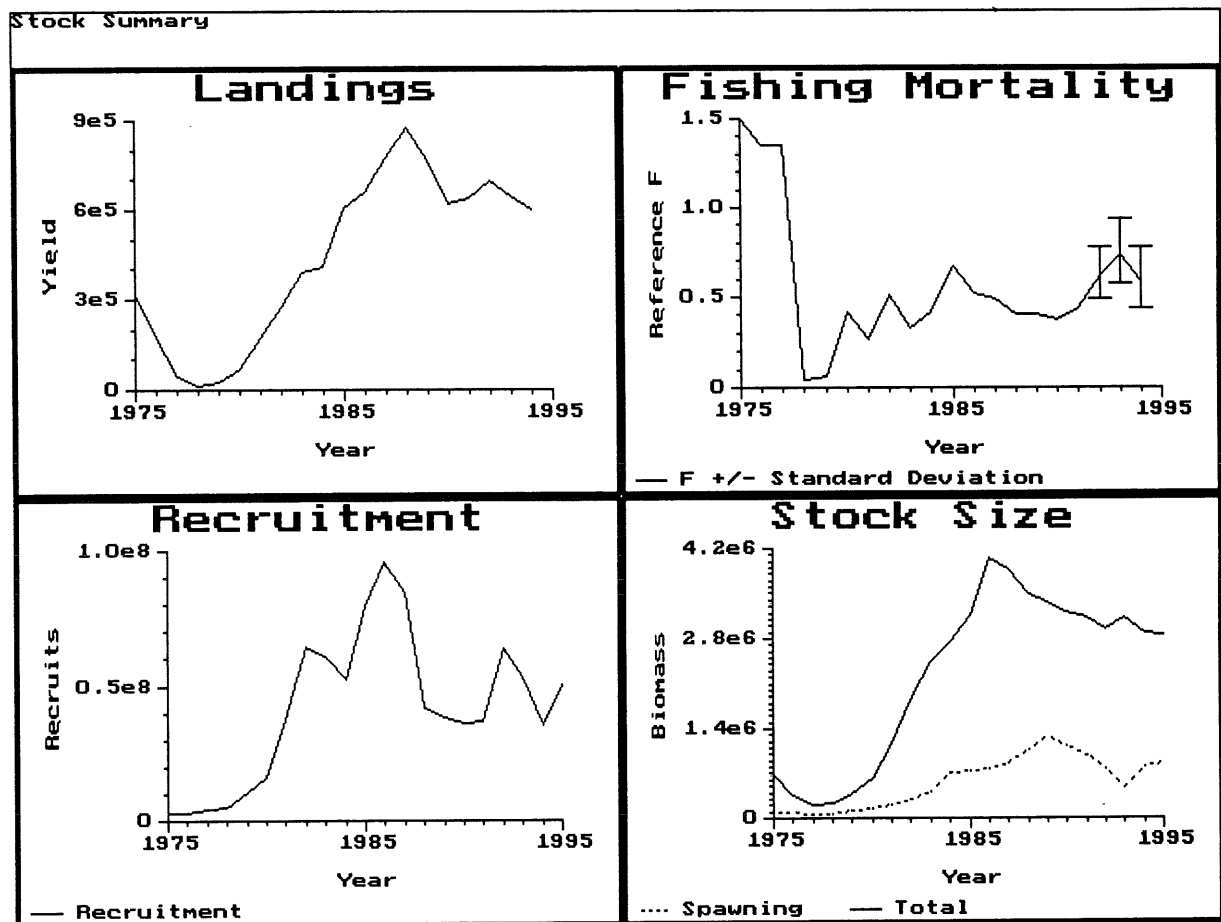


Figure 2.7.2

Separable Model Diagnostics

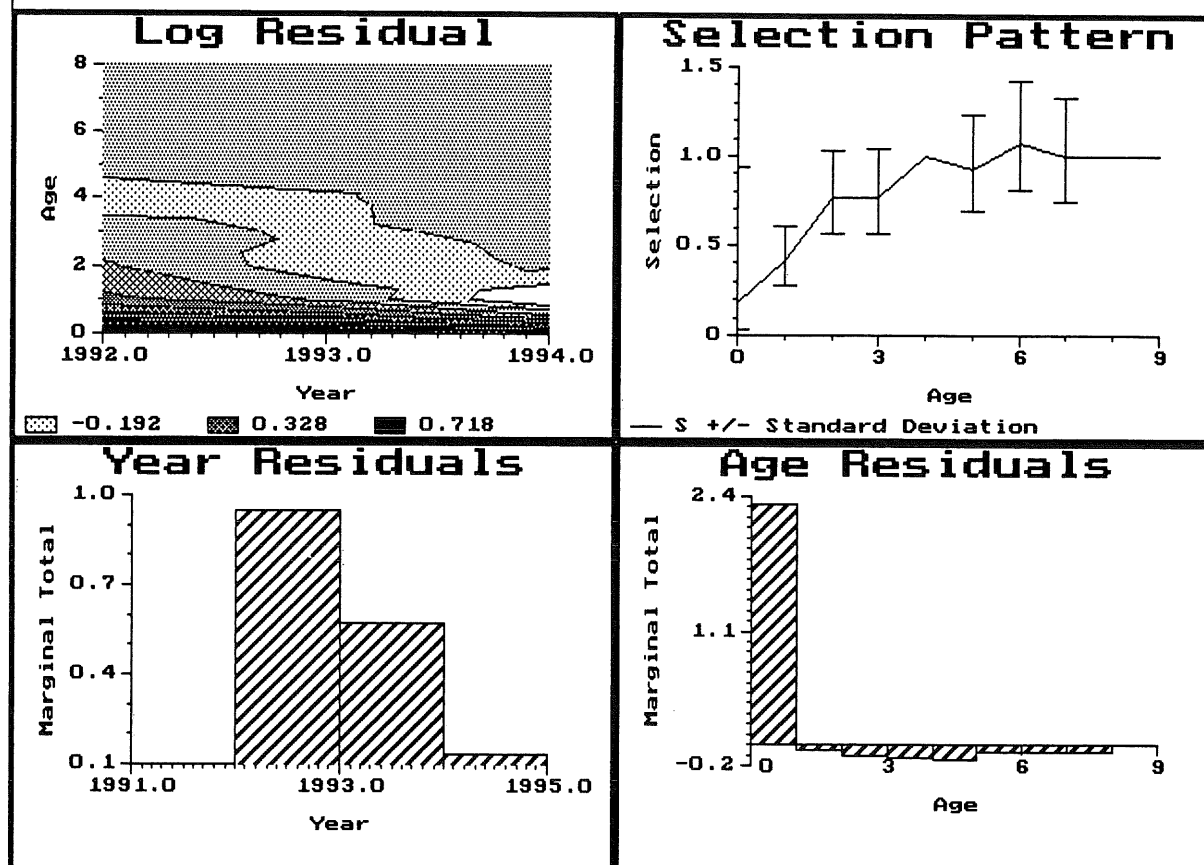


Figure 2.7.3

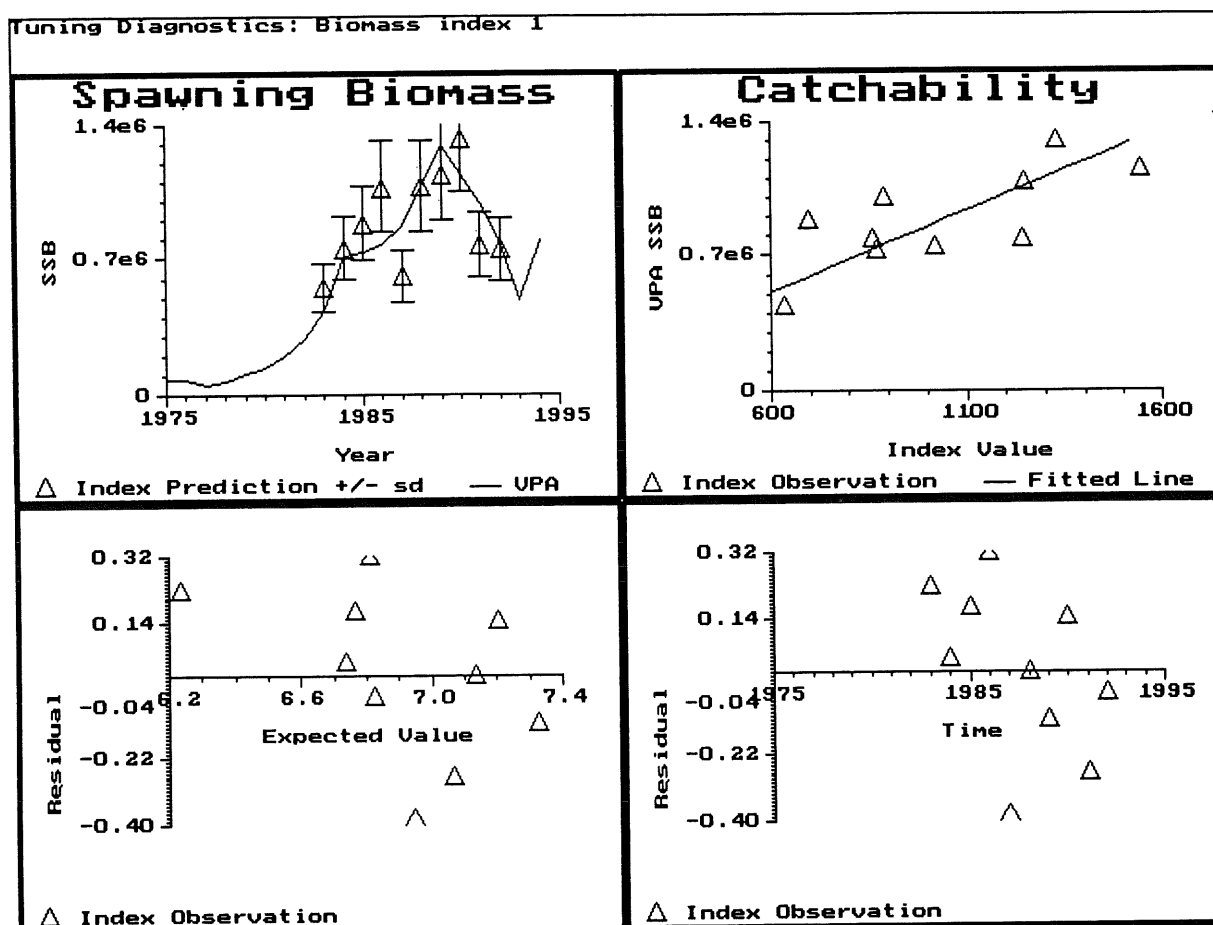


Figure 2.7.4

Tuning Diagnostics: Aged Index 1 at age 2

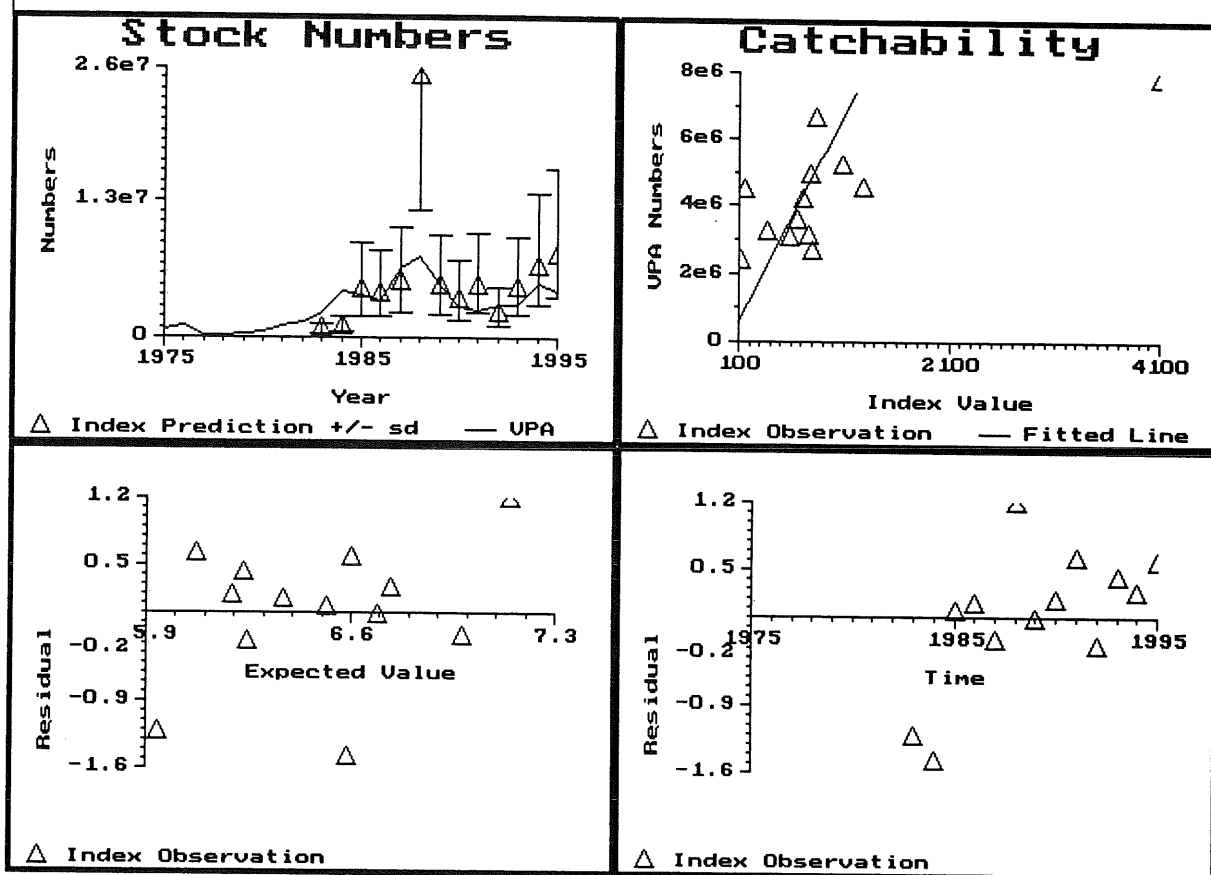


Figure 2.7.5

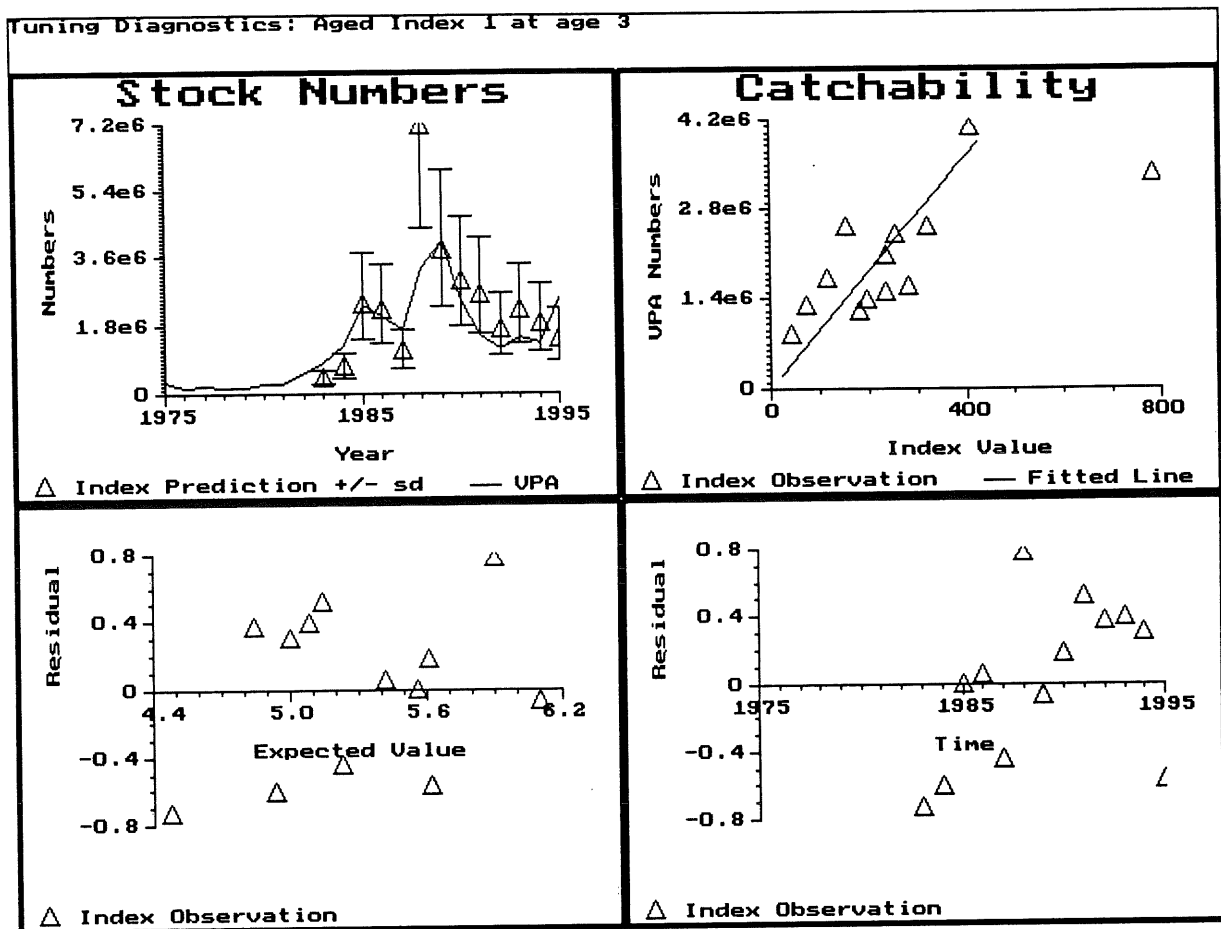


Figure 2.7.6

Tuning Diagnostics: Aged Index 1 at age 4

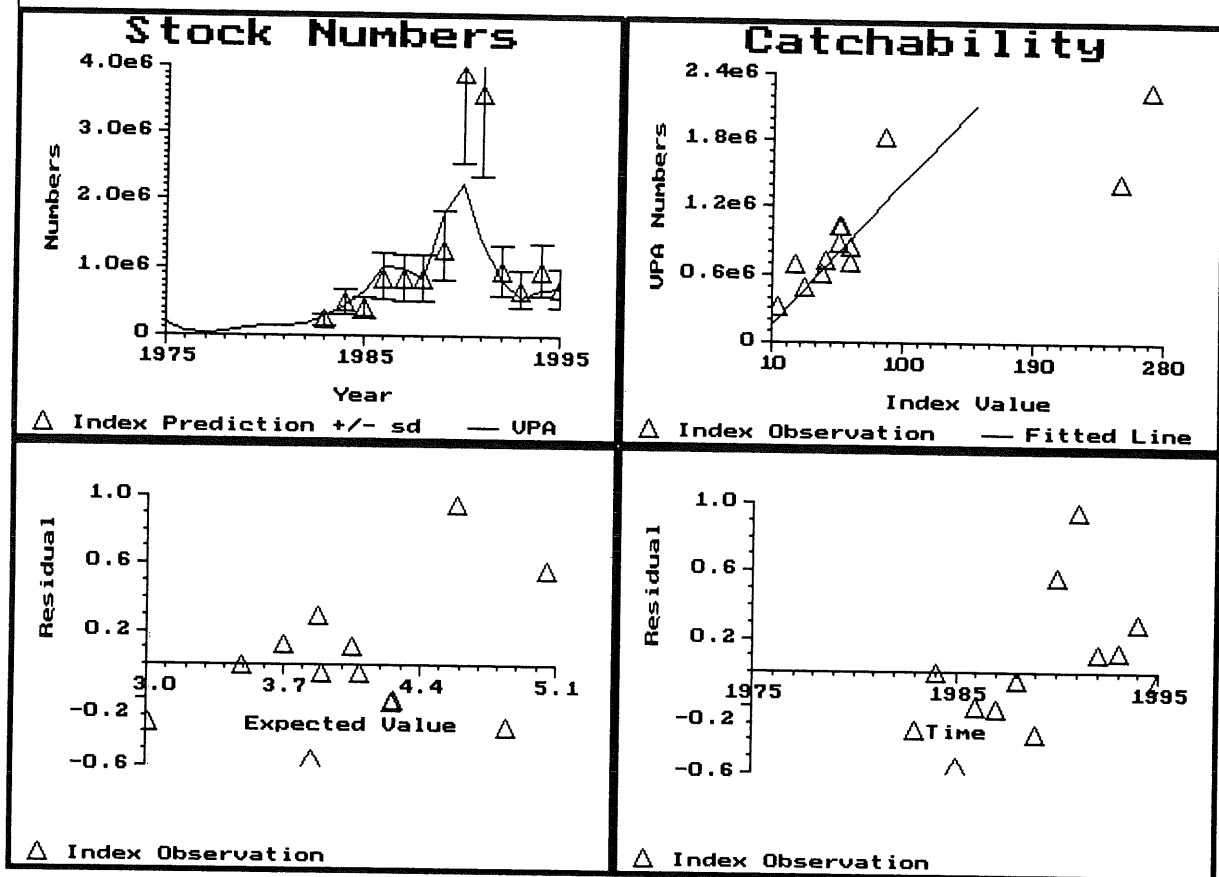


Figure 2.7.7

Tuning Diagnostics: Aged Index 1 at age 5

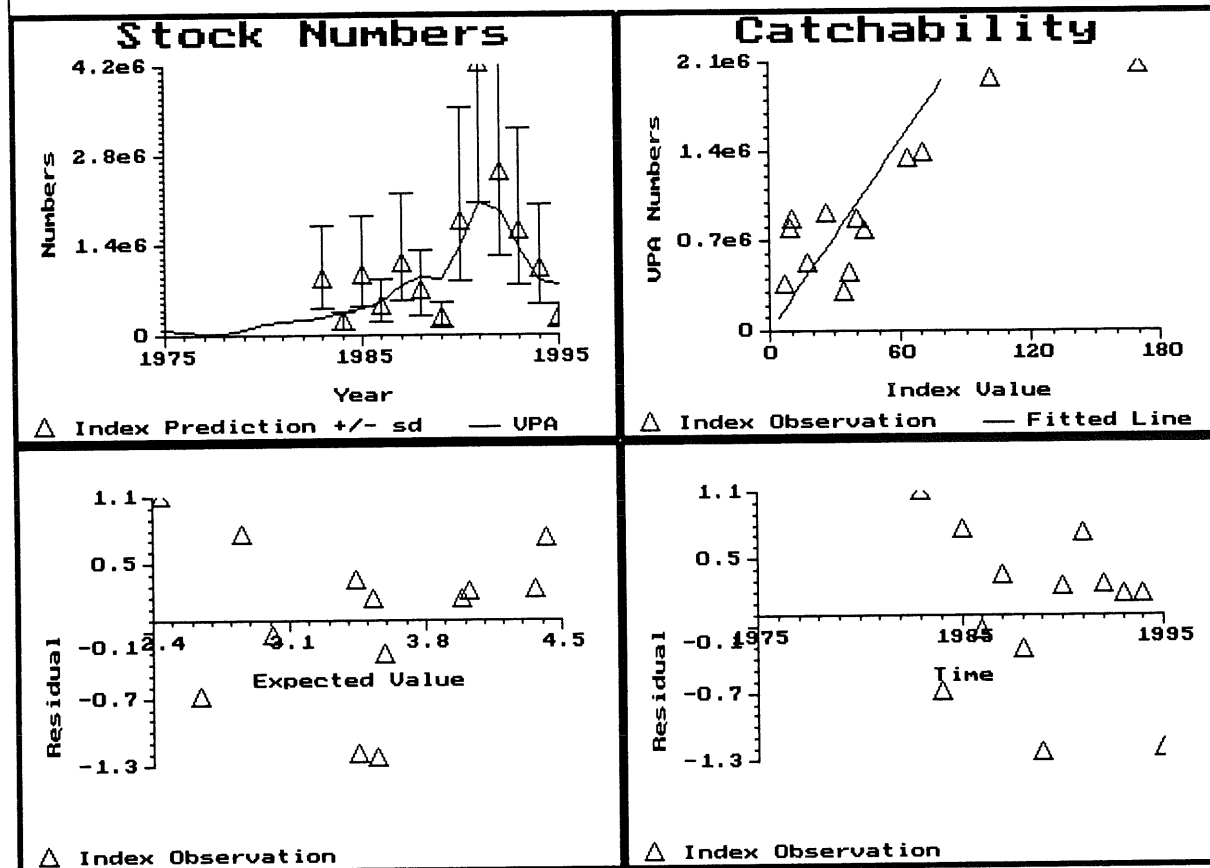


Figure 2.7.8

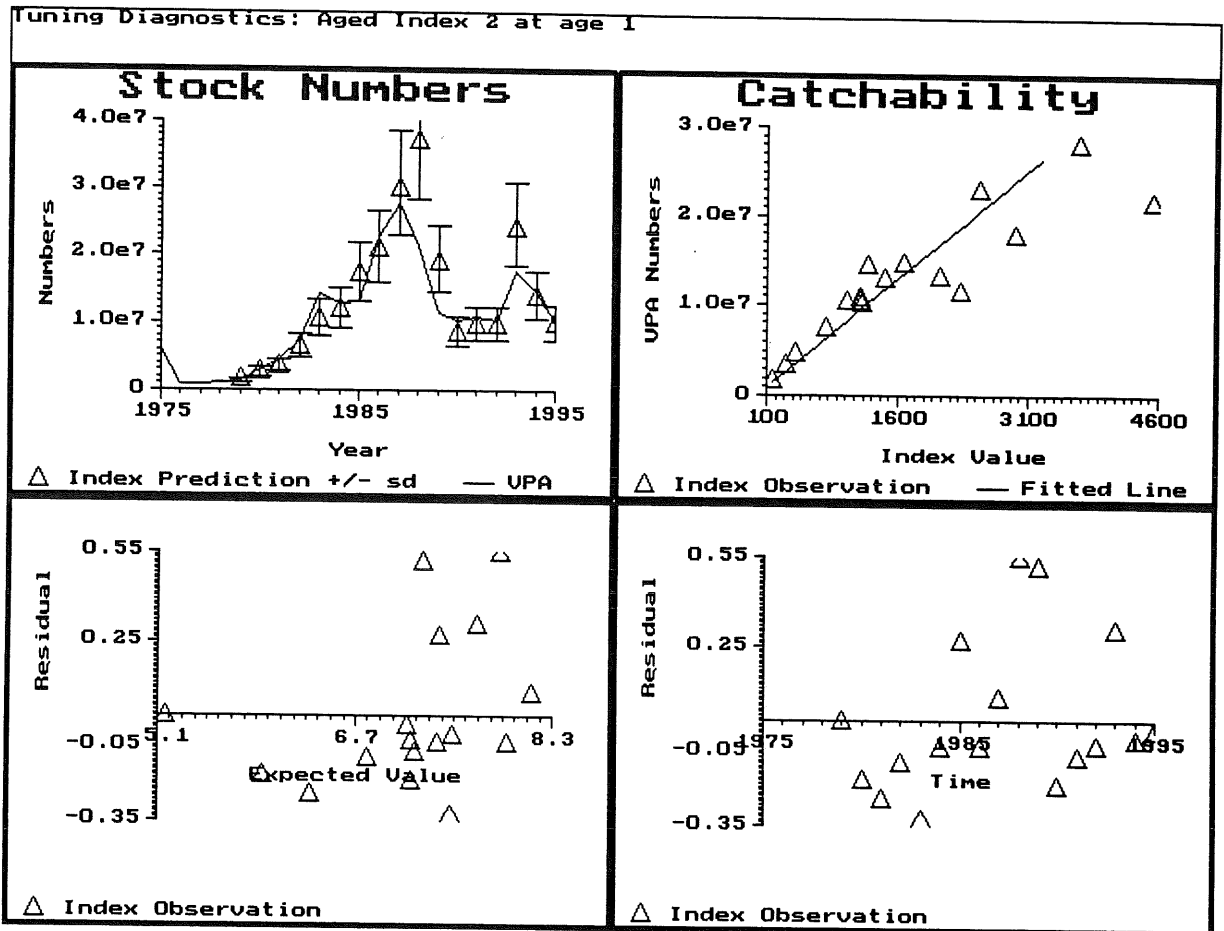


Figure 2.7.9

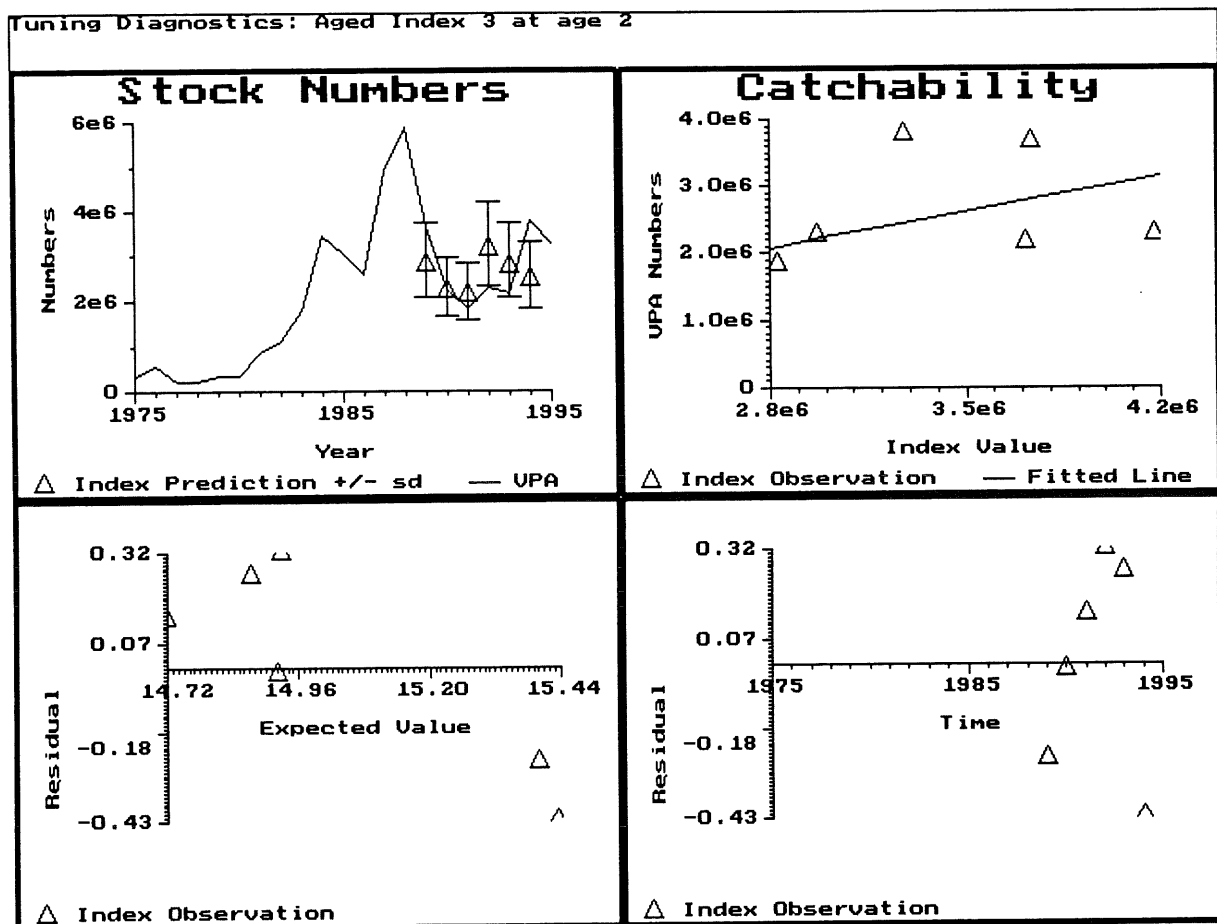


Figure 2.7.10

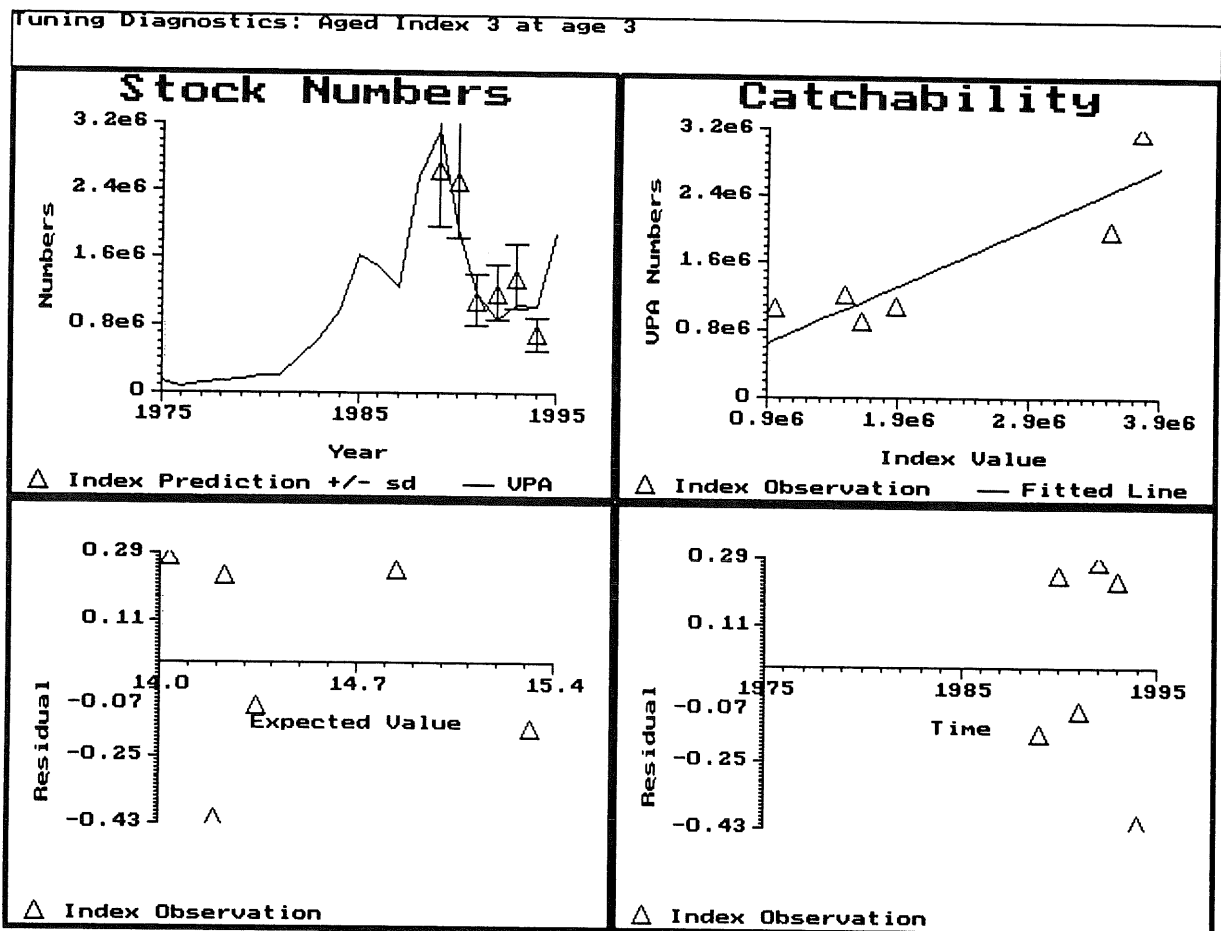


Figure 2.7.11

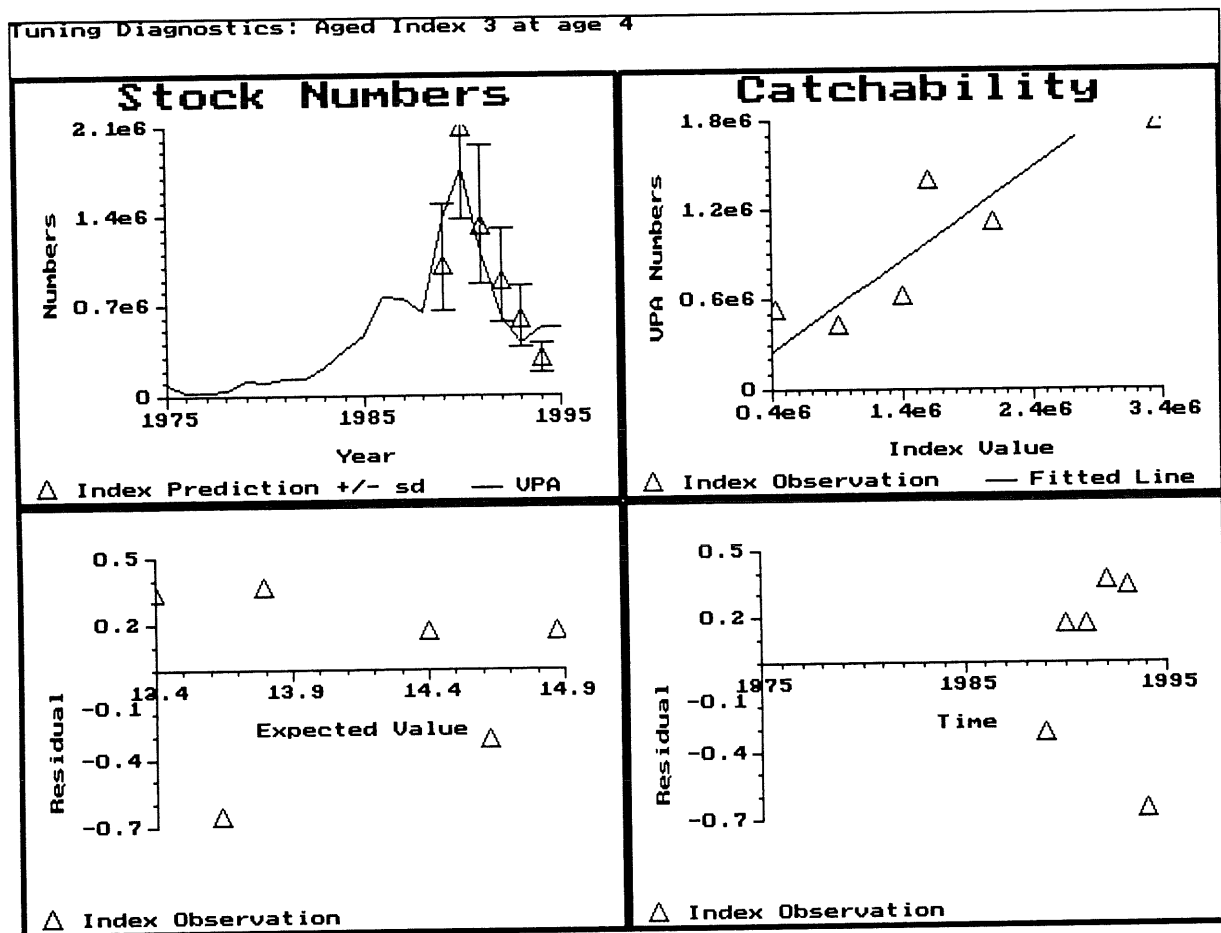


Figure 2.7.12

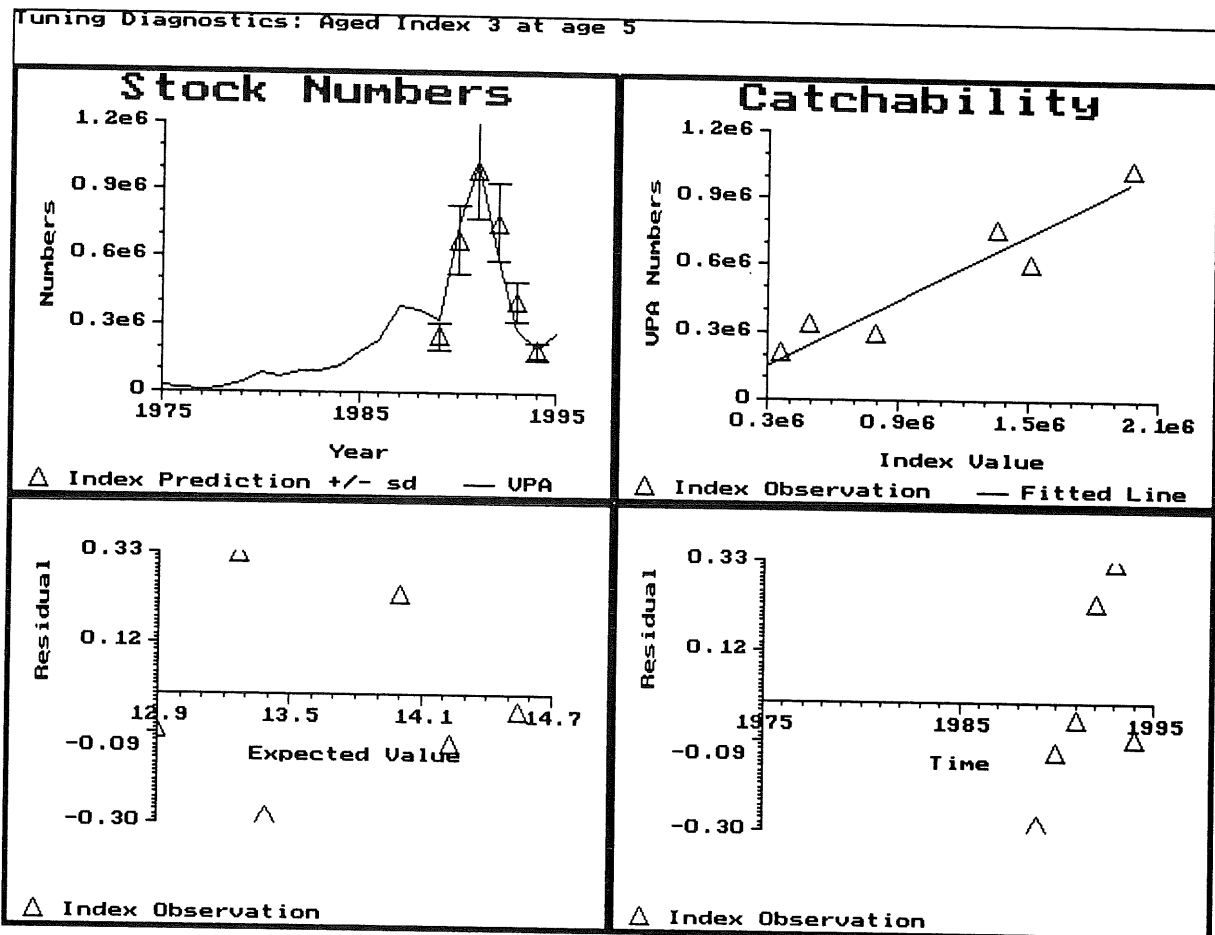


Figure 2.7.13

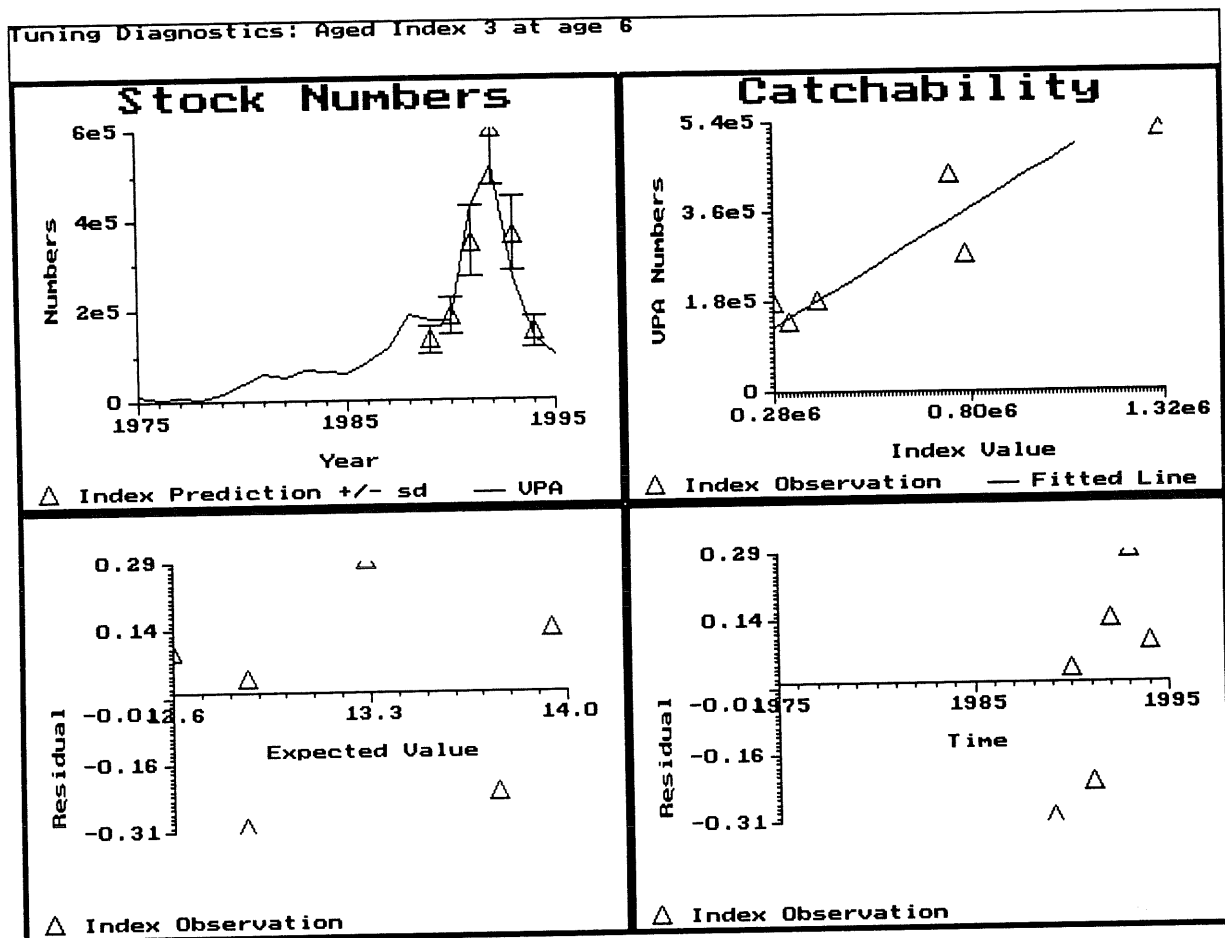


Figure 2.7.14

Tuning Diagnostics: Aged Index 3 at age 7

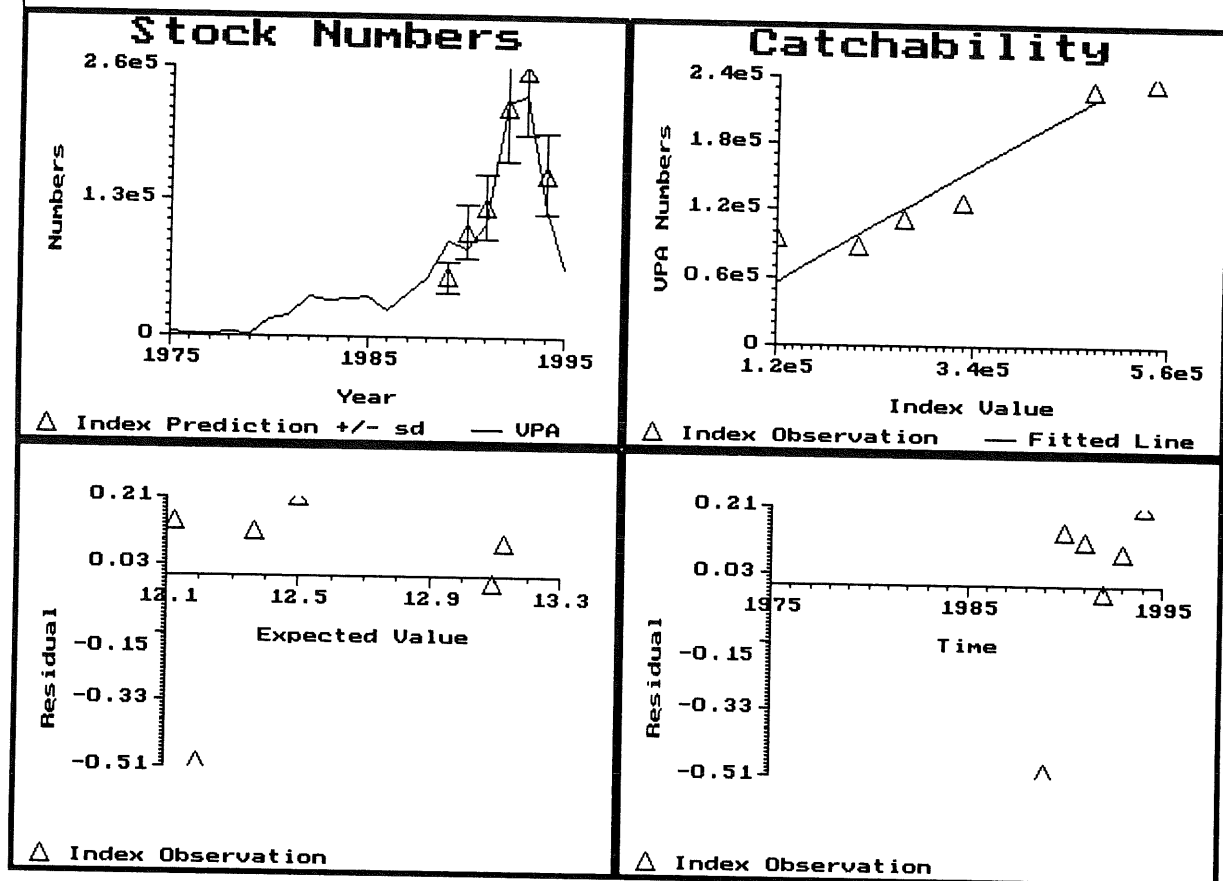


Figure 2.7.15

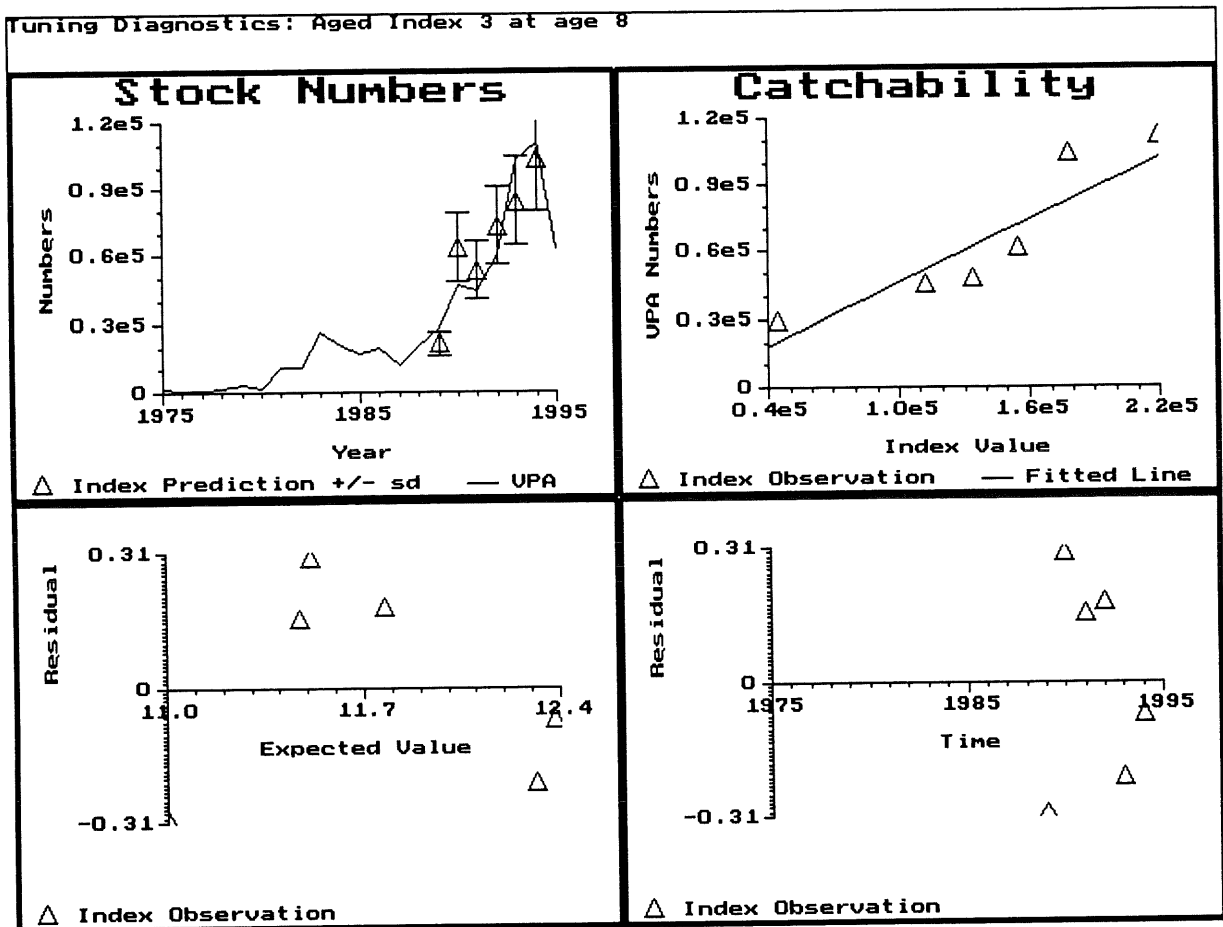


Figure 2.7.16

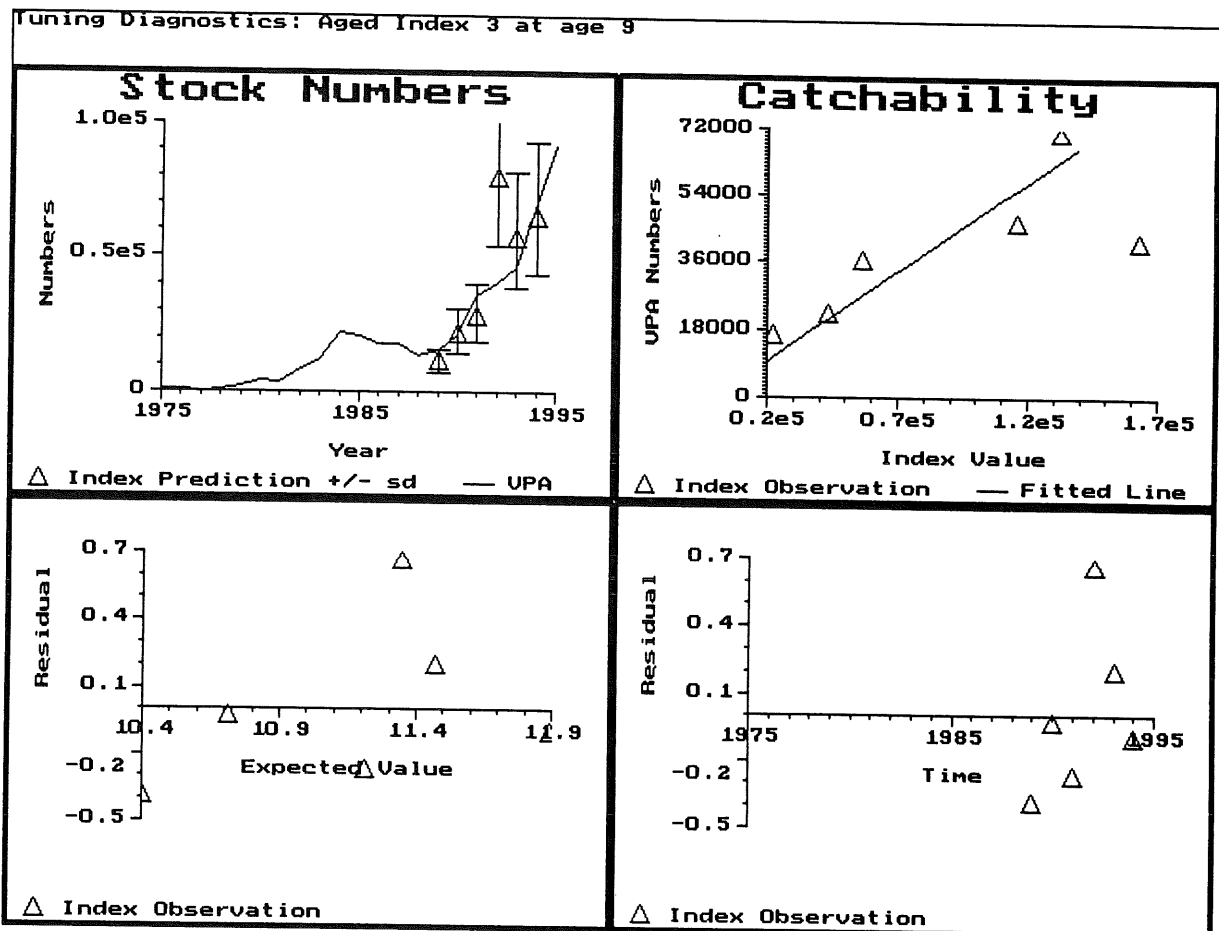


Figure 2.7.17

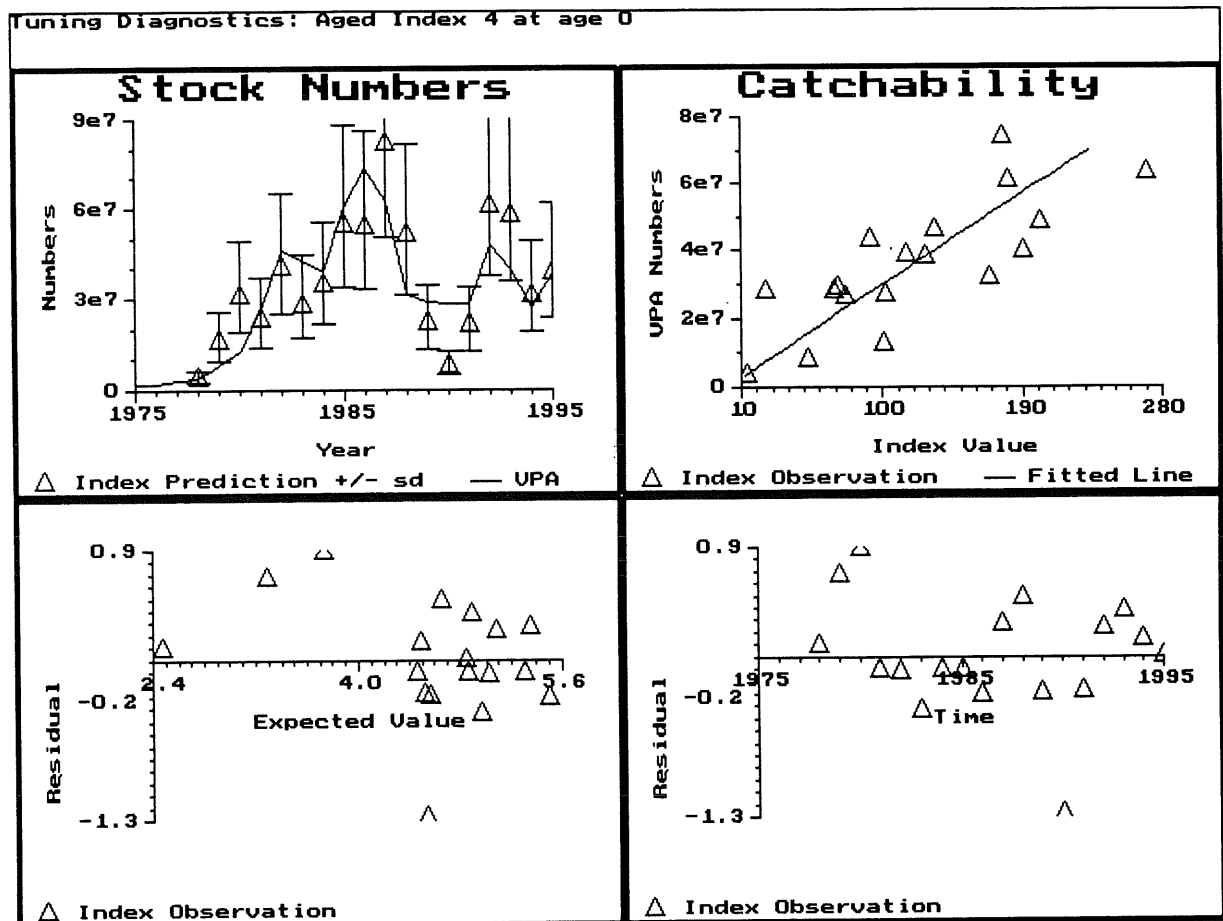
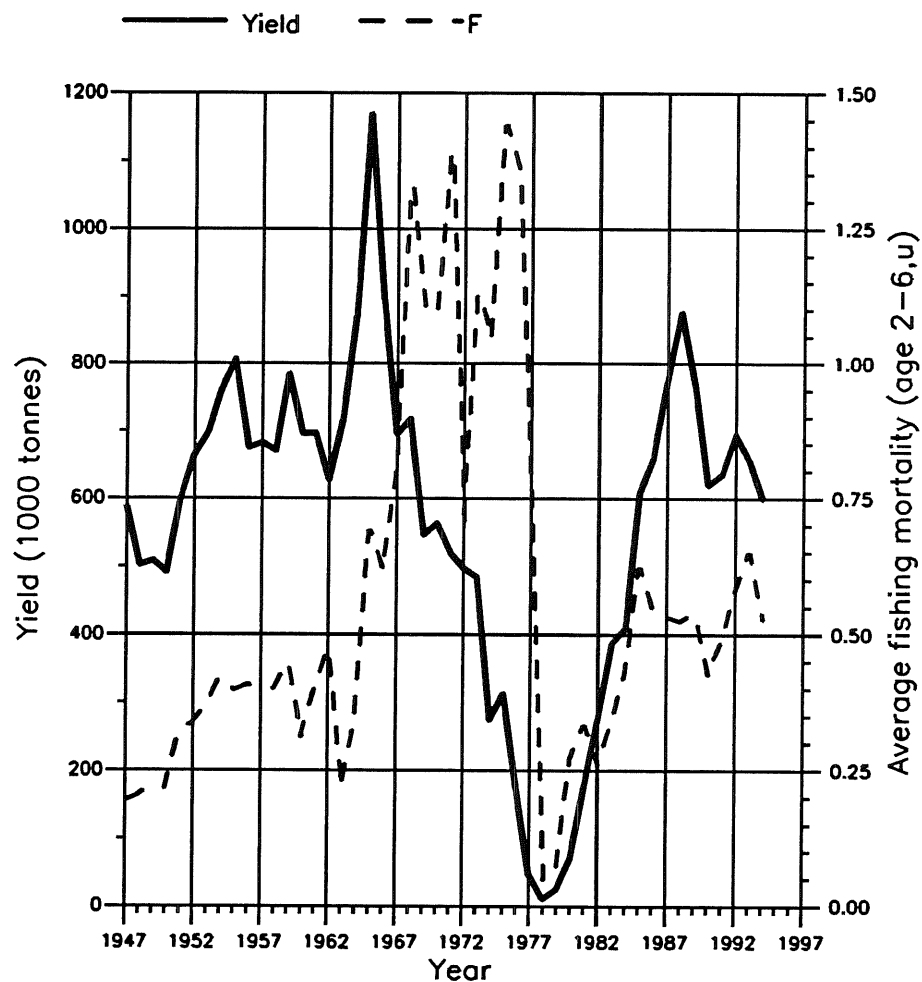


Figure 2.7.18

Figure 2.7.19

FISH STOCK SUMMARY **STOCK: Herring – North Sea Autumn Spawning Stock** **5 – 4 – 1995**

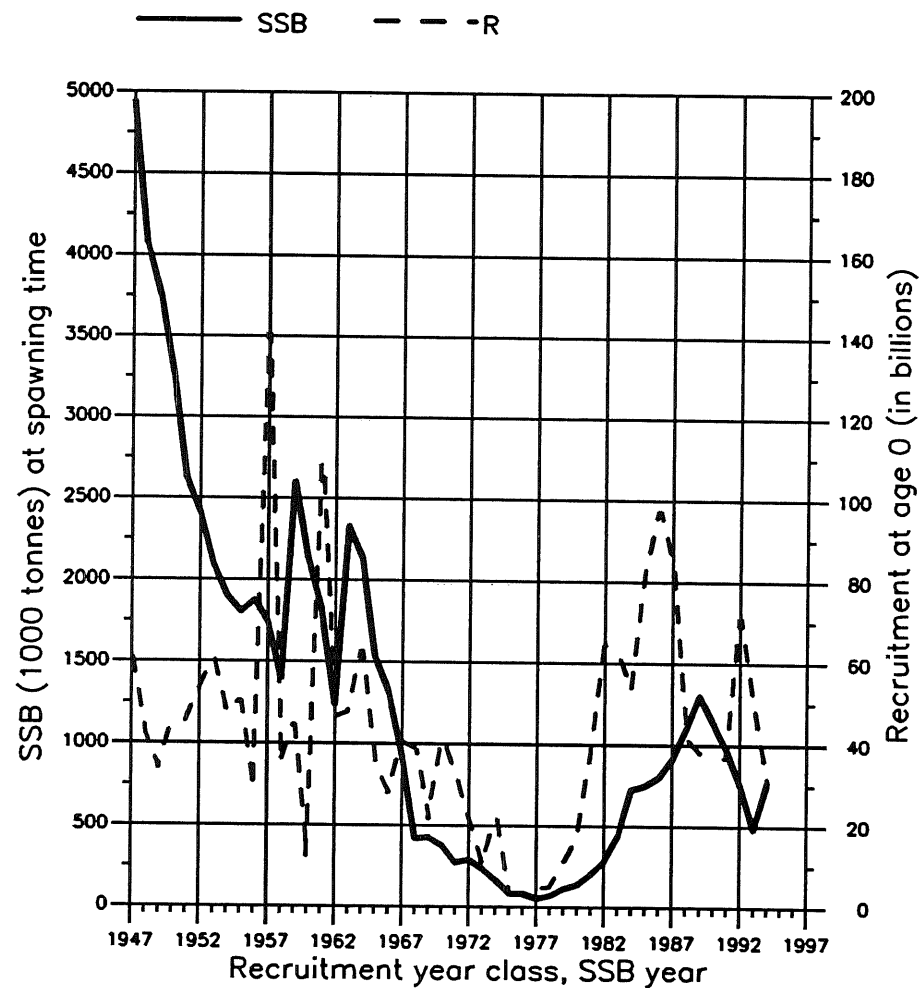
Trends in yield and fishing mortality (F)



(run: HS1)

A

Trends in spawning stock biomass (SSB) and recruitment (R)



(run: HS1)

B

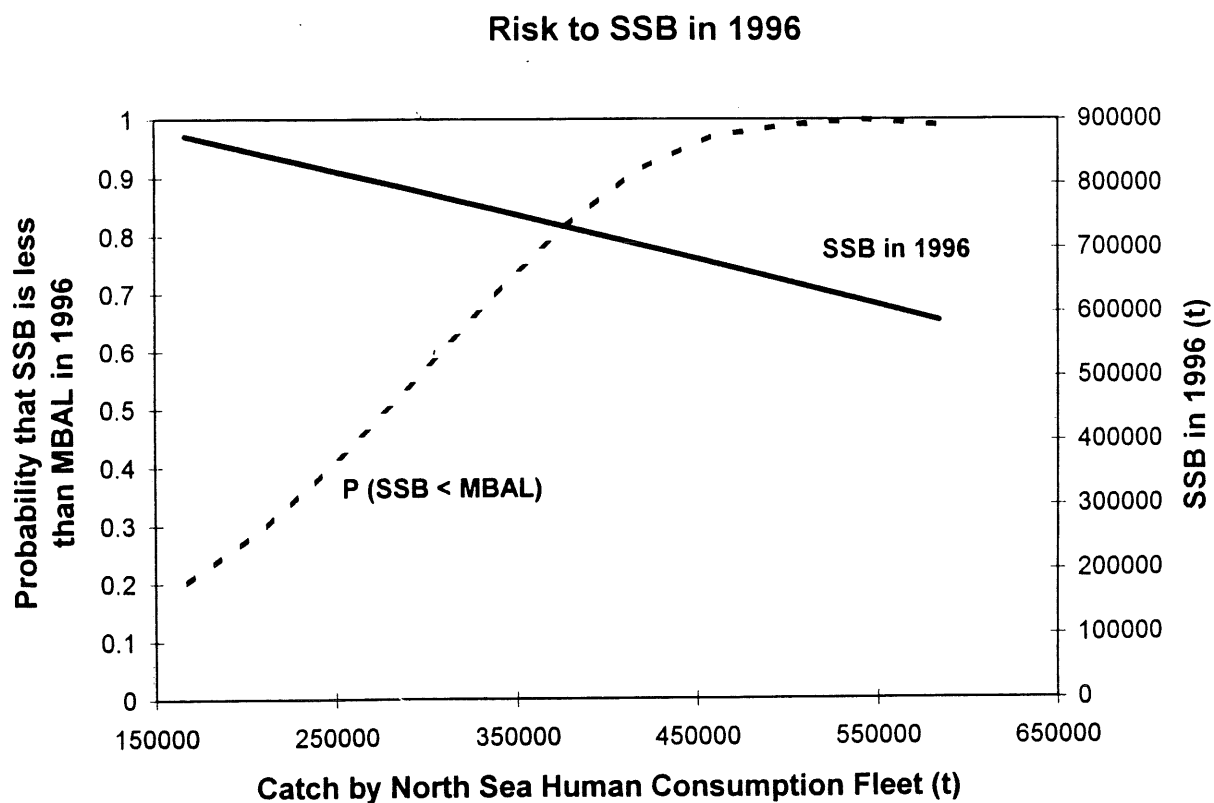
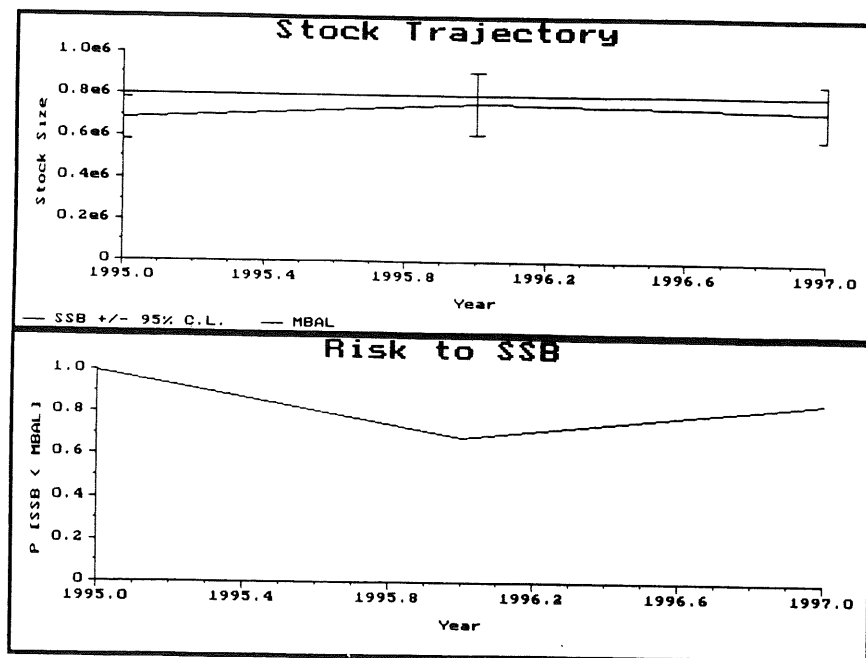


Figure 2.9.1. A calculation of the risk to the spawning stock in 1996. The probability ogive represents the likelihood that the spawning stock in 1996 will be below MBAL, given that catches in 1995 by all fleets remain at their mean levels from 1992 to 1994, and for different levels of catches by the North Sea human consumption fishery.

b)



a)

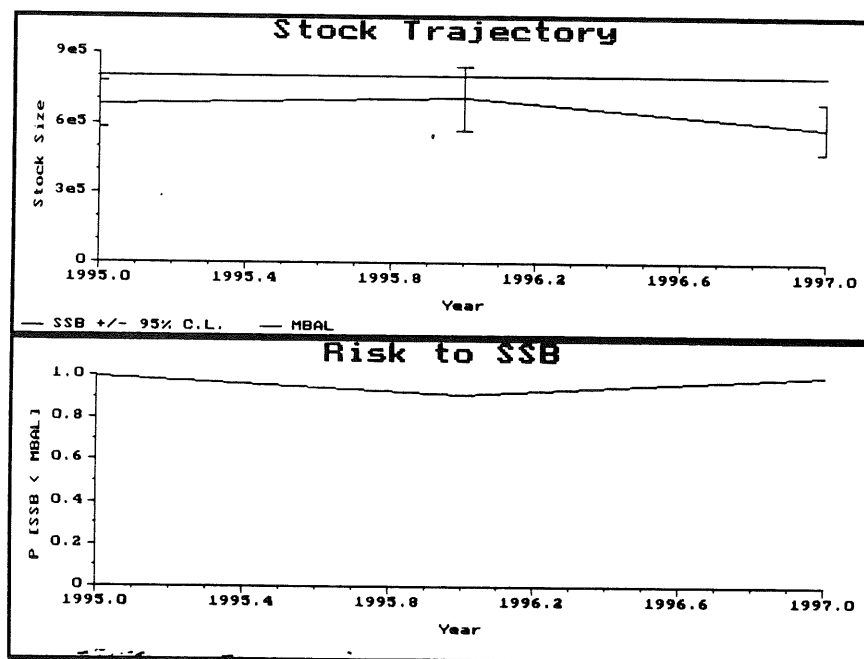


Figure 2.9.2. a) Estimated stock trajectory and associated probability that the stock will be below MBAL in each of three years, given that catches in all fleets remain constant for three years at their mean levels for the past 3 years. b) The comparable trajectory for a 20% reduction in the catches by the North Sea human consumption fishery in 1996 and 1997.

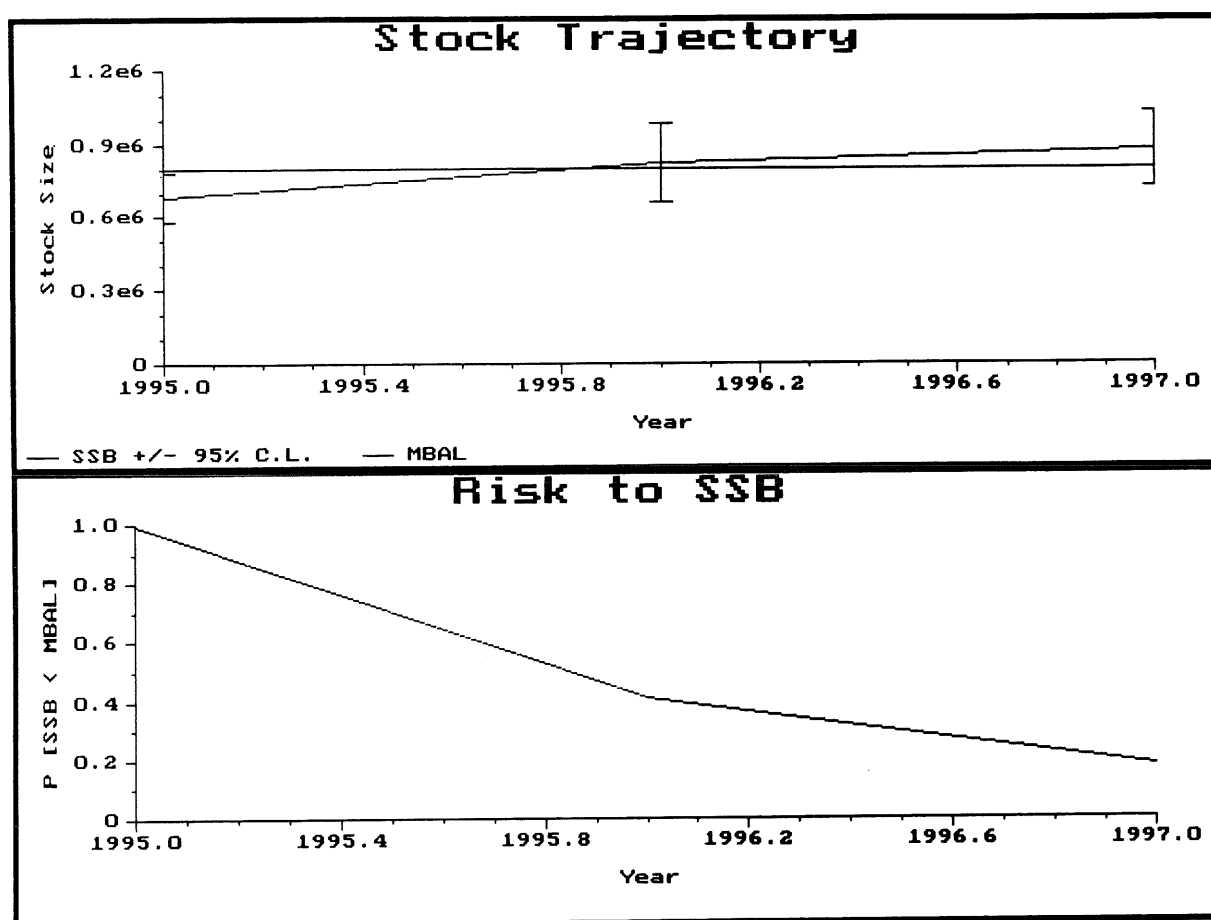
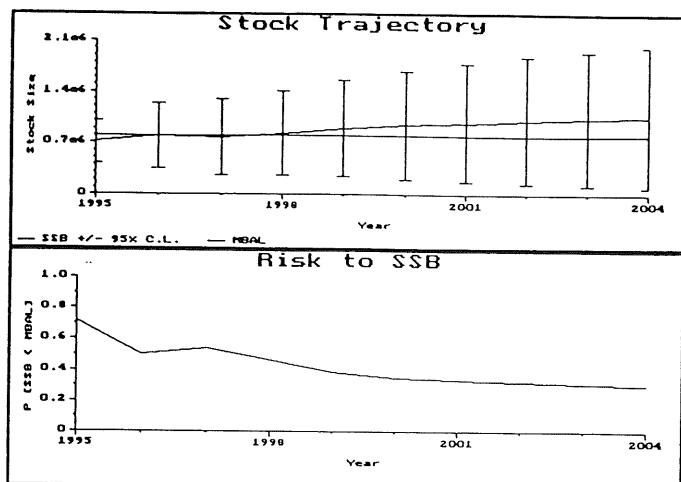
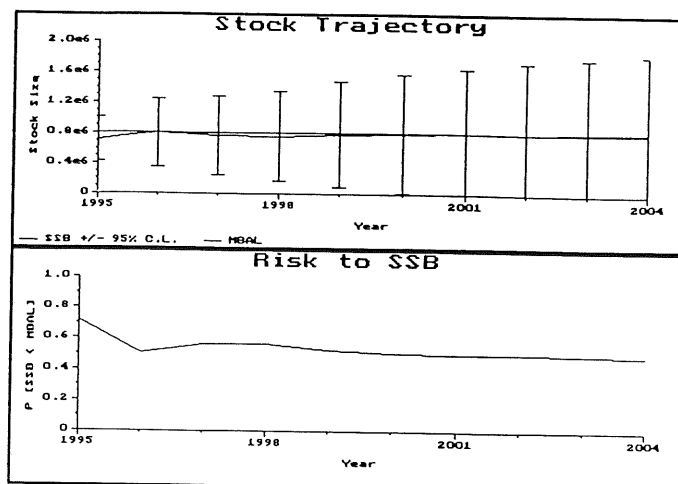


Figure 2.9.3. Estimated stock trajectory and associated probability that the stock will be below MBAL in each of three years, assuming that catches in 1995 will be at mean levels for the past 3 years, and that catches by the human consumption fishery in the North Sea in 1996 and 1997 will be 250 000t.

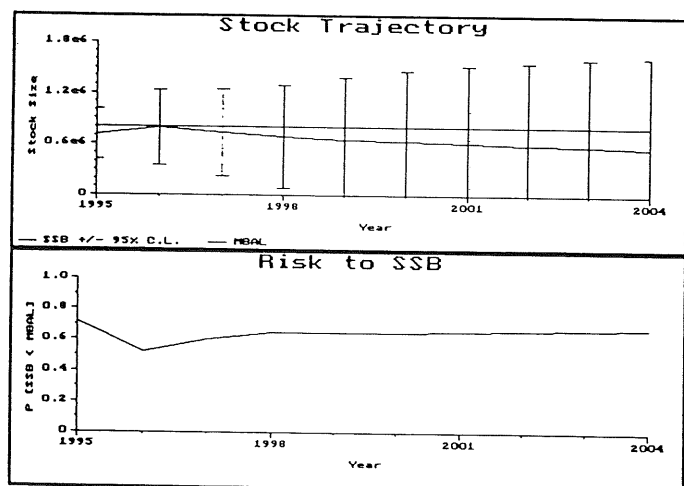
A



B



C



D

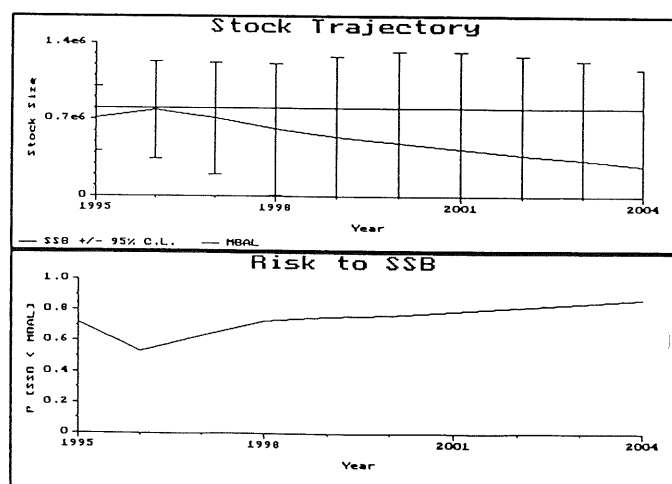
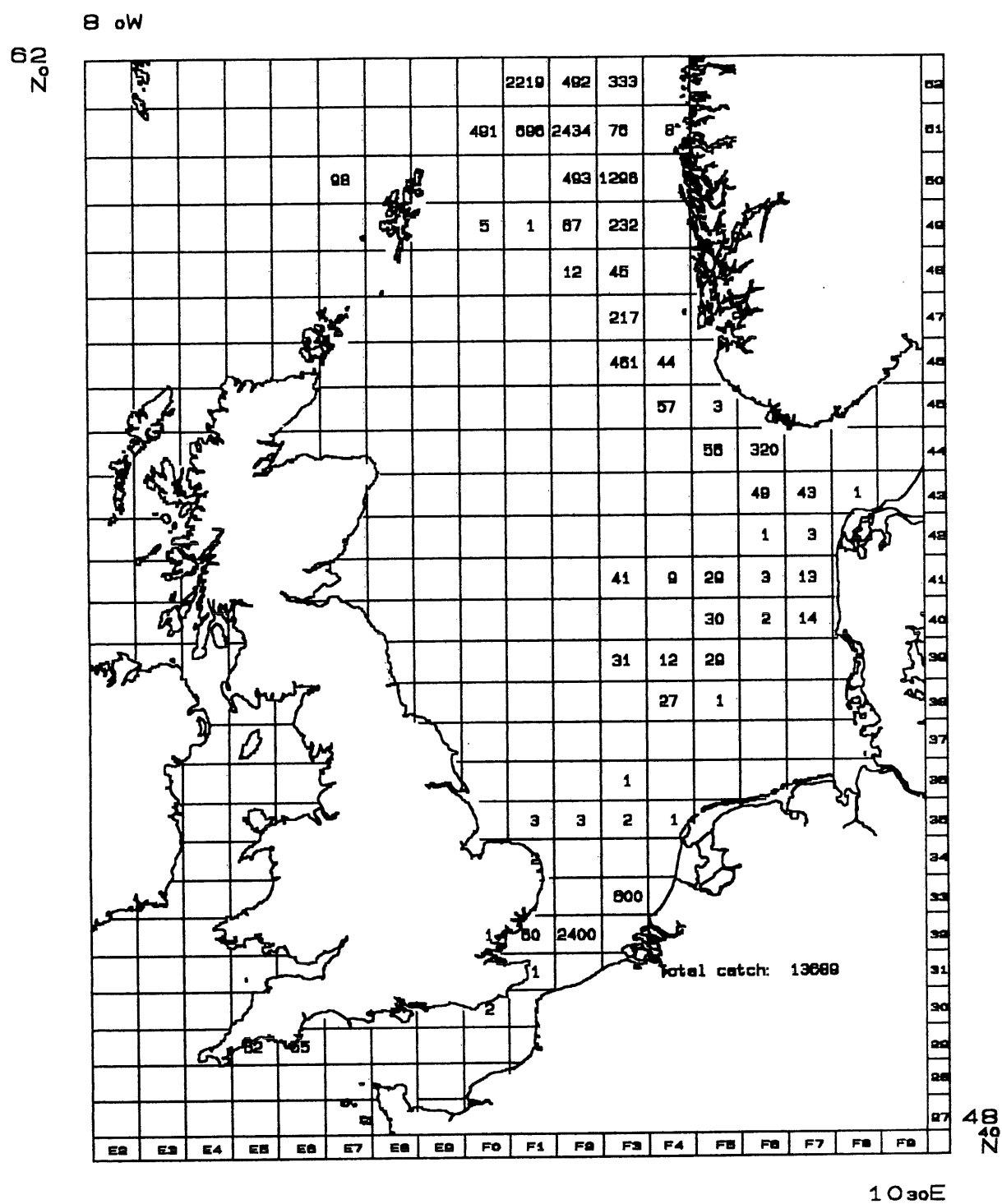


Figure 2.9.4. Estimated stock trajectories for status quo fishing mortalities in all fleets, except for fleet B in which case the partial fishing mortalities have been adjusted so that the central estimate of the fleet catch have been set to zero (A), 50 000t (B), 100 000t (C) and 150 000t (D) respectively.

Figure 2.11.1 Herring North Sea catches (tonnes) - January 1994



Map showing the distribution of Atlantic halibut catches in 1988, plotted against latitude (47°N to 49°N) and longitude (8°W to 10°E). The map includes the coastlines of Greenland, Iceland, and the British Isles. Catch data is presented as numbers within grid cells. A total catch of 14888 is indicated.

Latitude	8°W	9°W	10°W	9°E	10°E
49°N		80	2783	17	9
48°N			273	1097	878
47°N		317	188	15	13
46°N	81				418
45°N				38	1
44°N				158	1374
43°N				698	118
42°N			479	545	745
41°N					48
40°N			128		
39°N					108
38°N					113
37°N					512
36°N					2
35°N					1
34°N					2
33°N					
32°N					
31°N					
30°N					
29°N					
28°N					
27°N					
26°N					
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34°S					
35°S					
36°S					
37°S					
38°S					
39°S					
40°					

Figure 2.11.3 Herring North Sea catches (tonnes) - March 1994

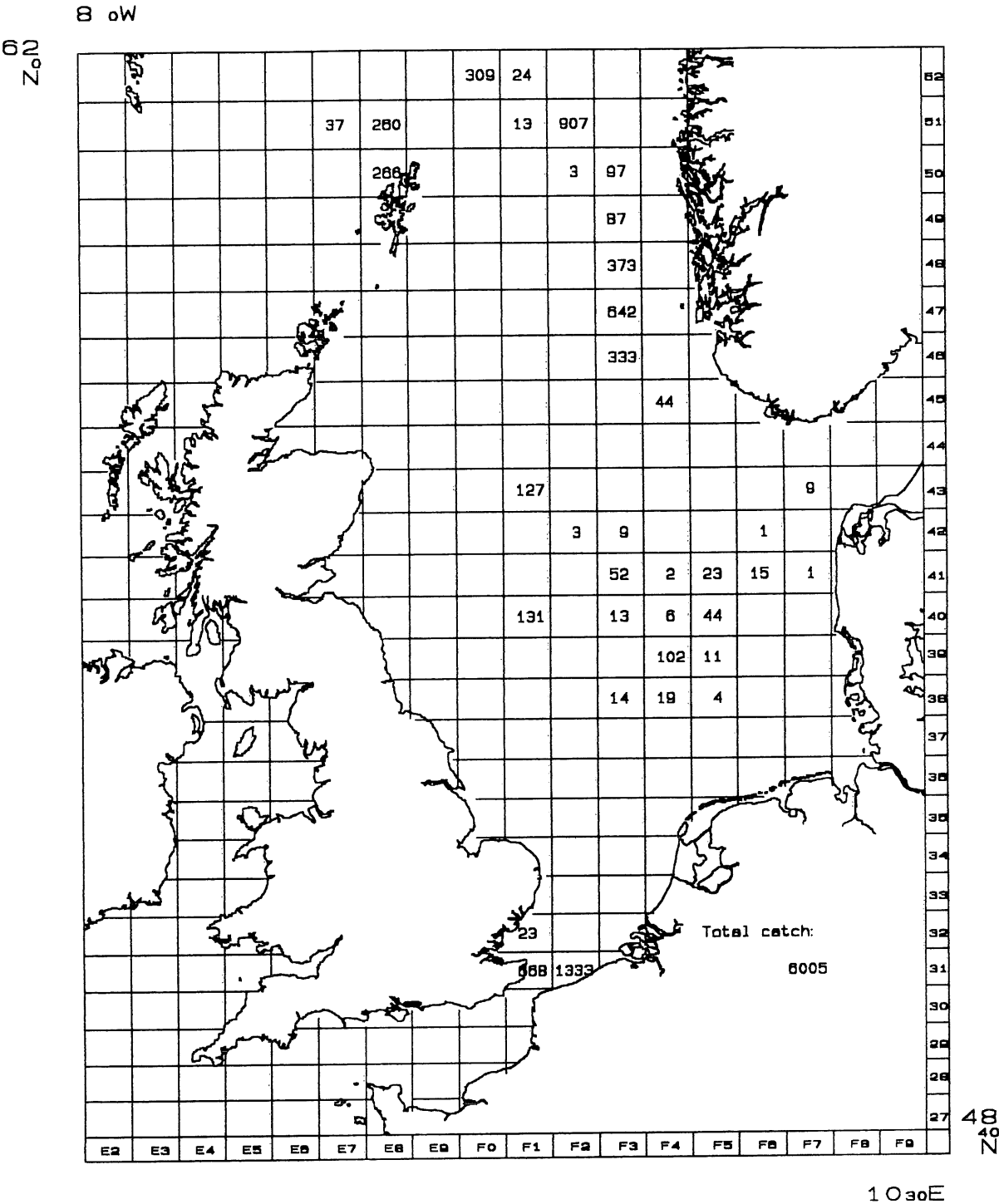


Figure 2.11.4 Herring North Sea catches (tonnes) - April 1994

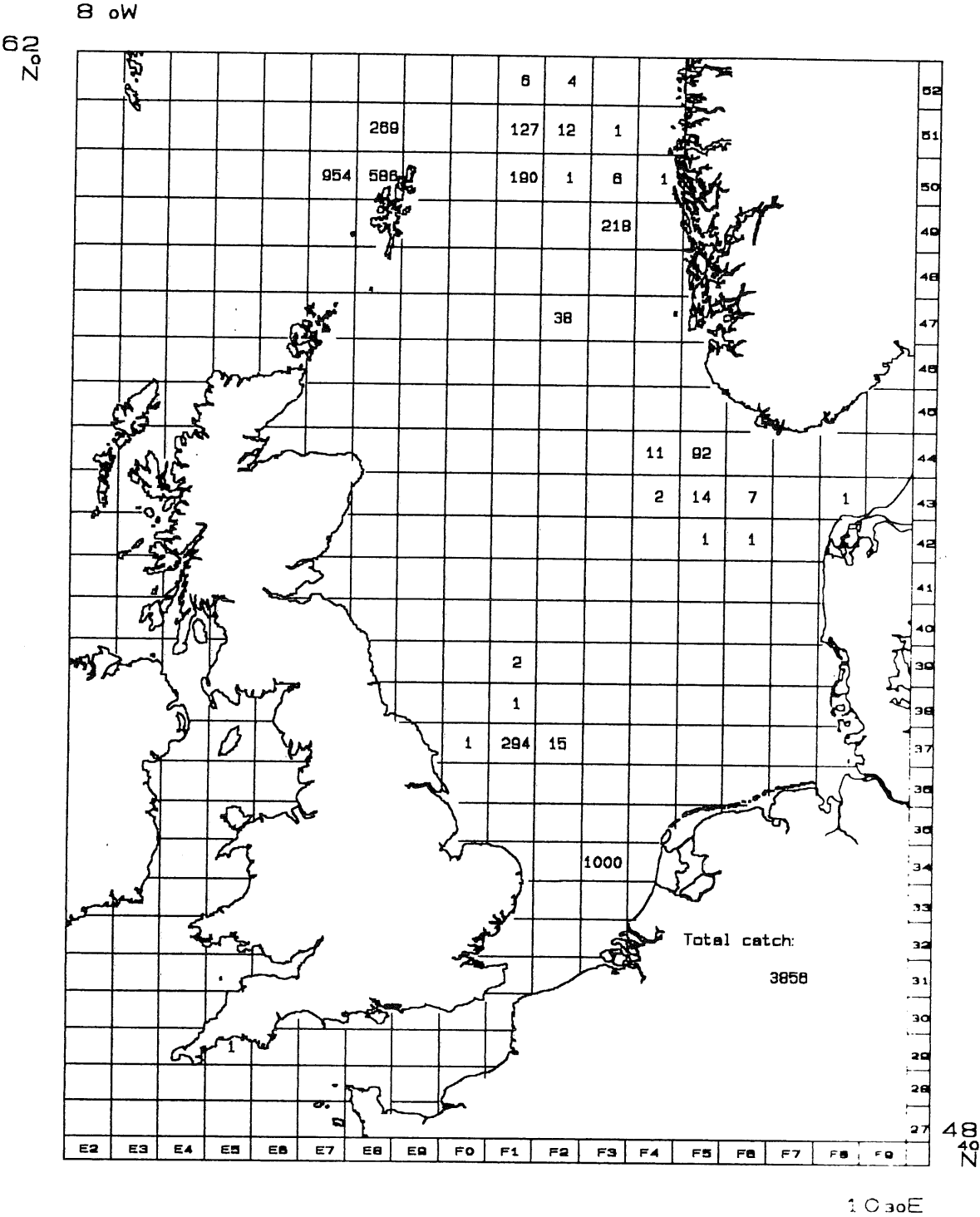


Figure 2.11.5 Herring North Sea catches (tonnes) - May 1994

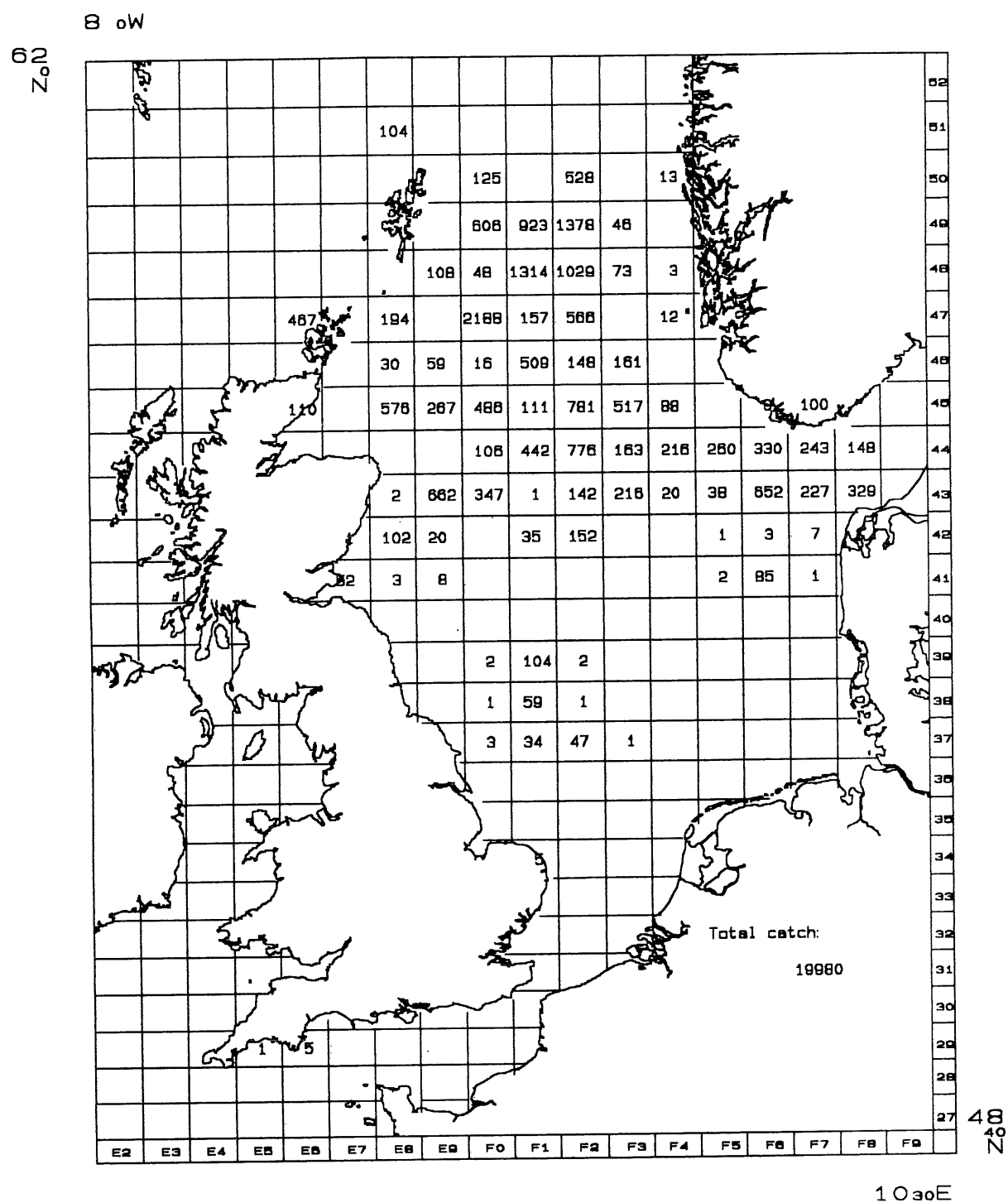


Figure 2.11.6 Herring North Sea catches (tonnes) - June 1994

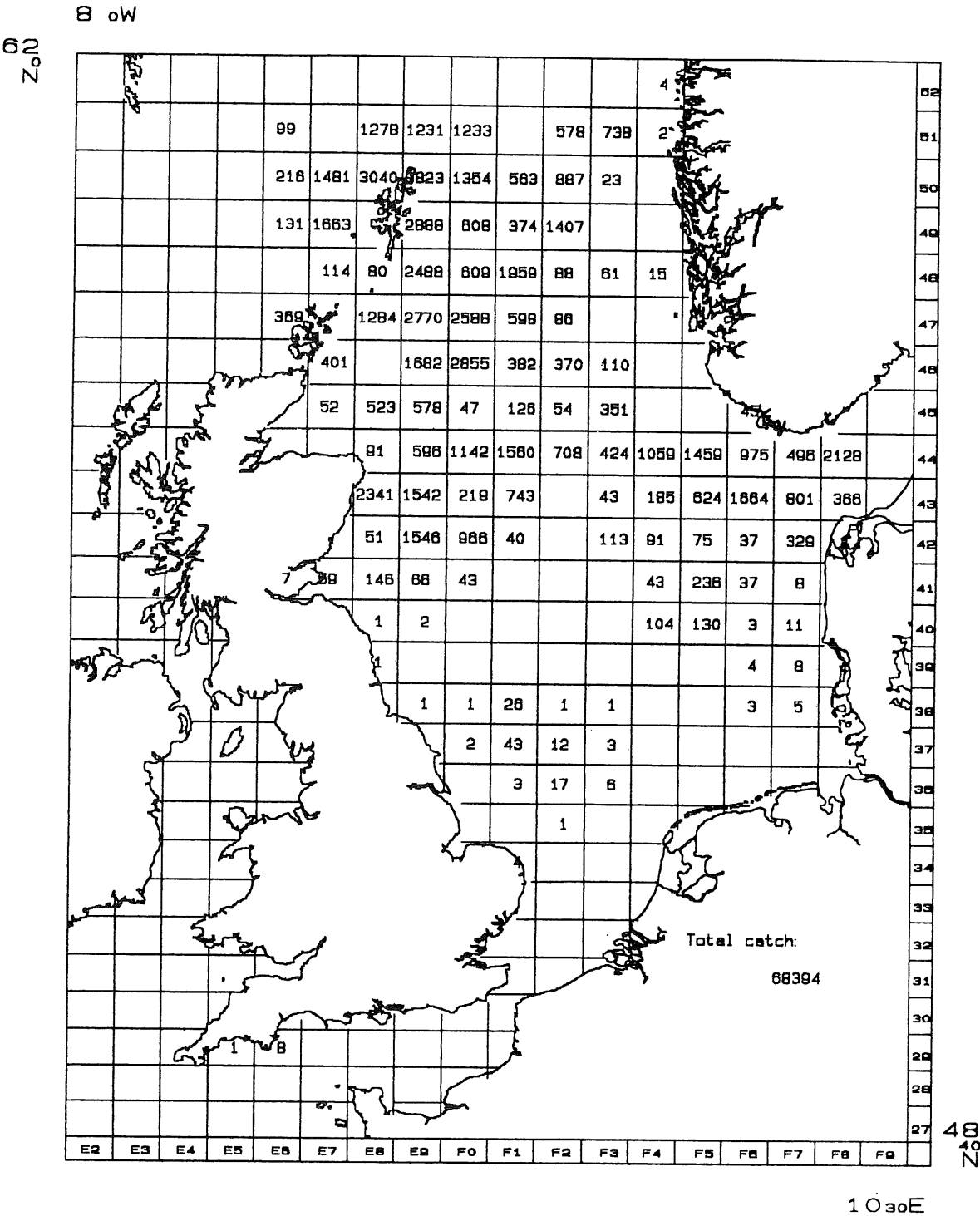


Figure 2.11.7 Herring North Sea catches (tonnes) - July 1994

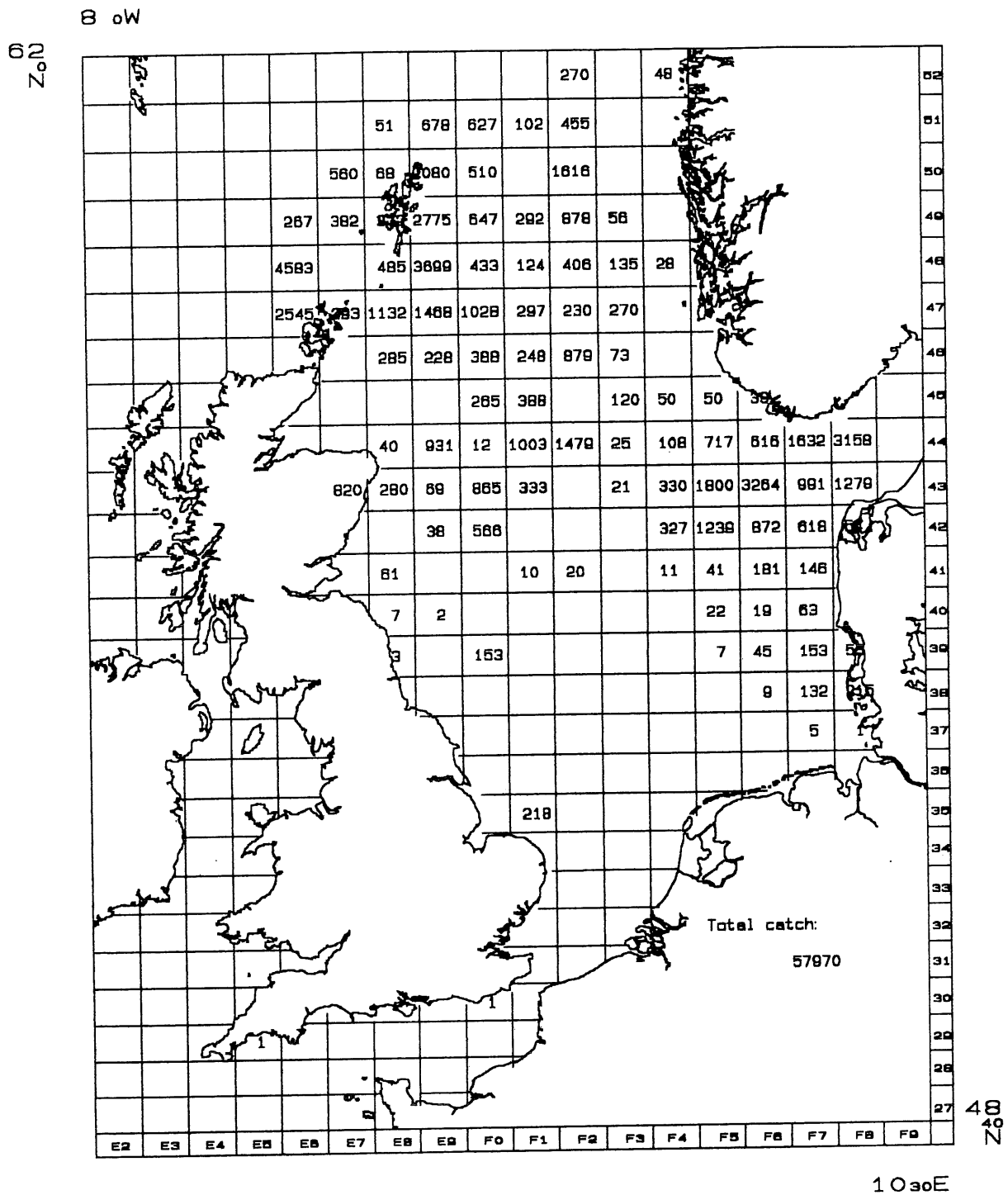


Figure 2.11.8 Herring North Sea catches (tonnes) - August 1994

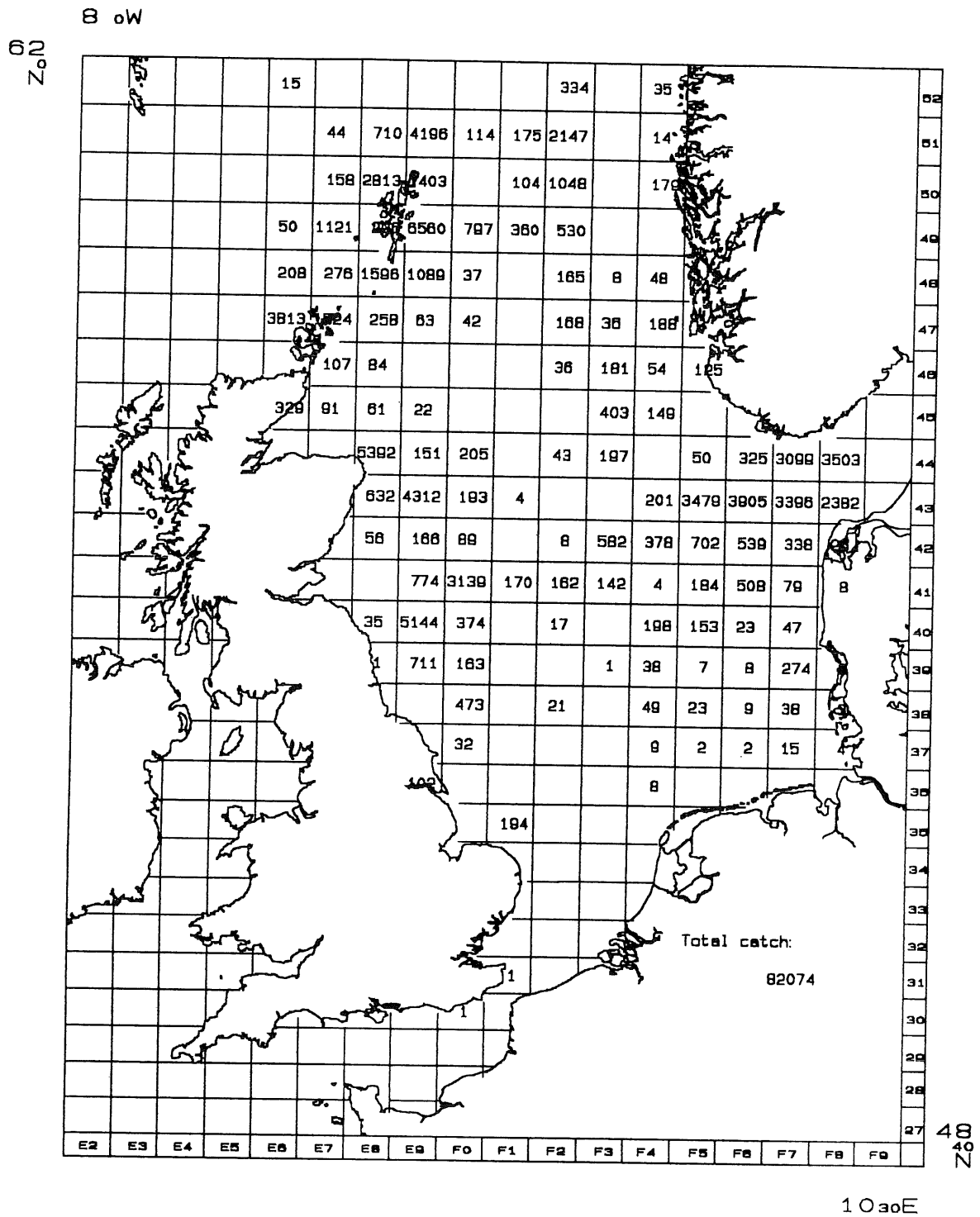


Figure 2.11.9 Herring North Sea catches (tonnes) - September 1994

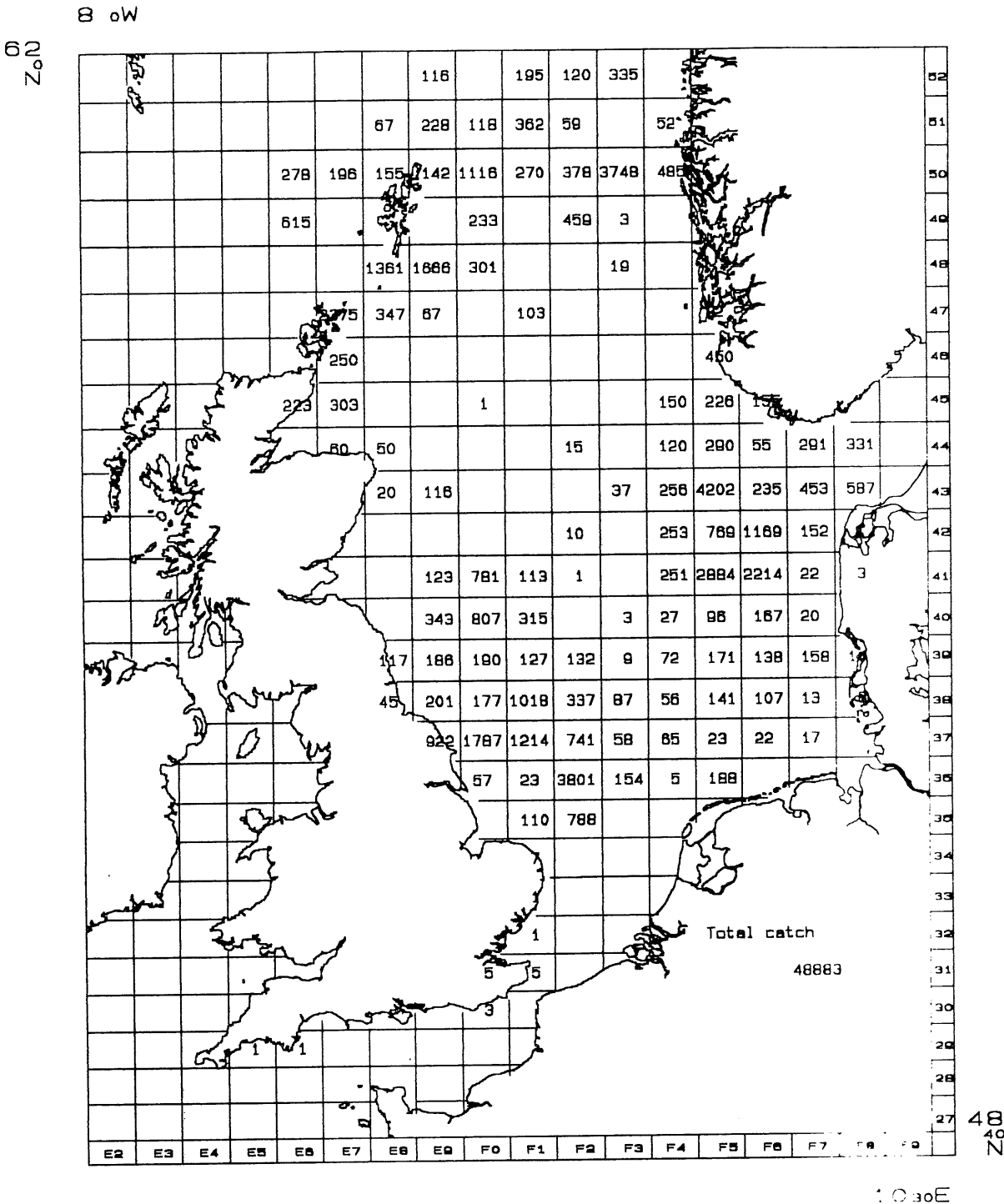


Figure 2.11.10 Herring North Sea catches (tonnes) - October 1994

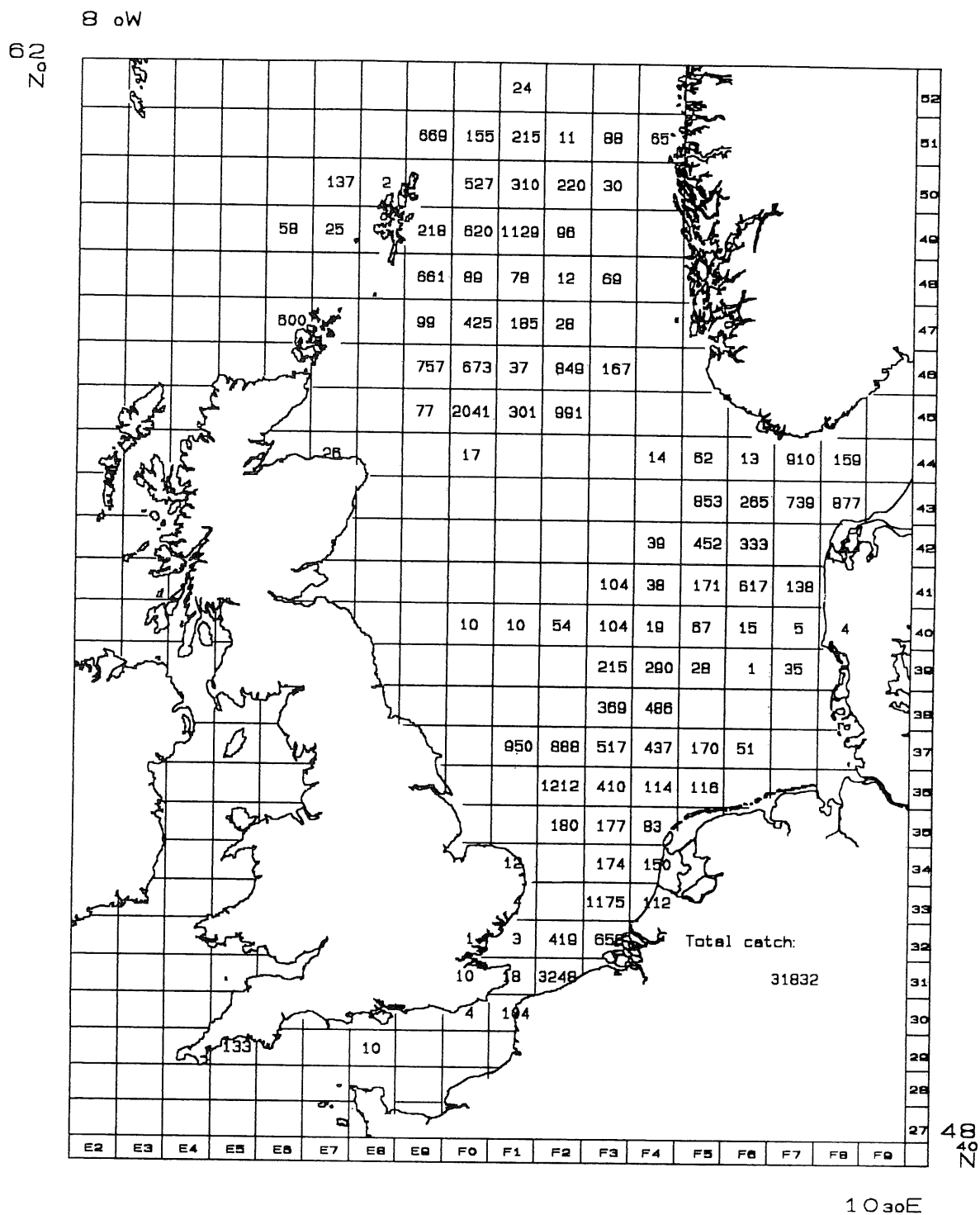


Figure 2.11.11 Herring North Sea catches (tonnes) - November 1994

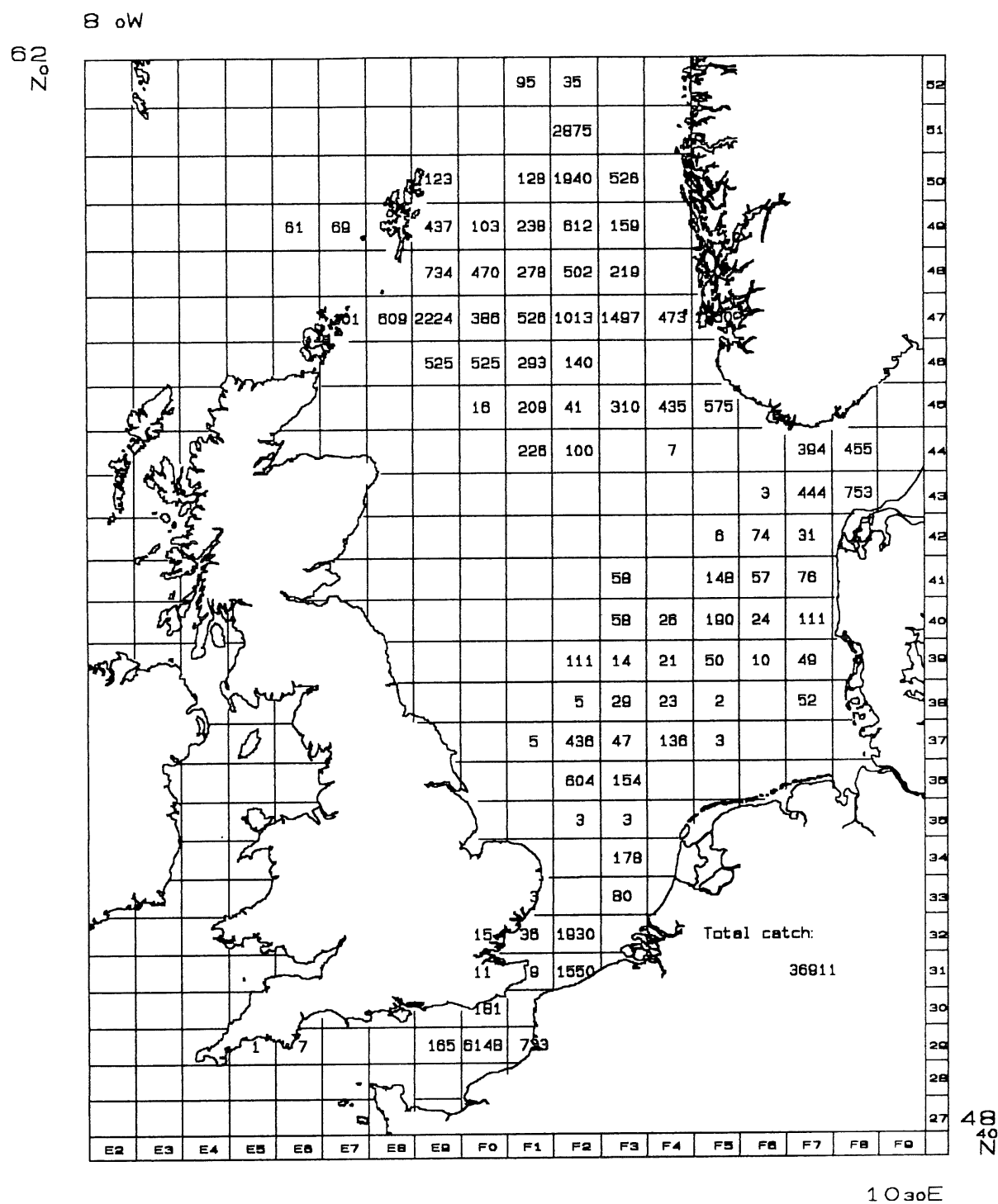


Figure 2.11.12 Herring North Sea catches (tonnes) - December 1994

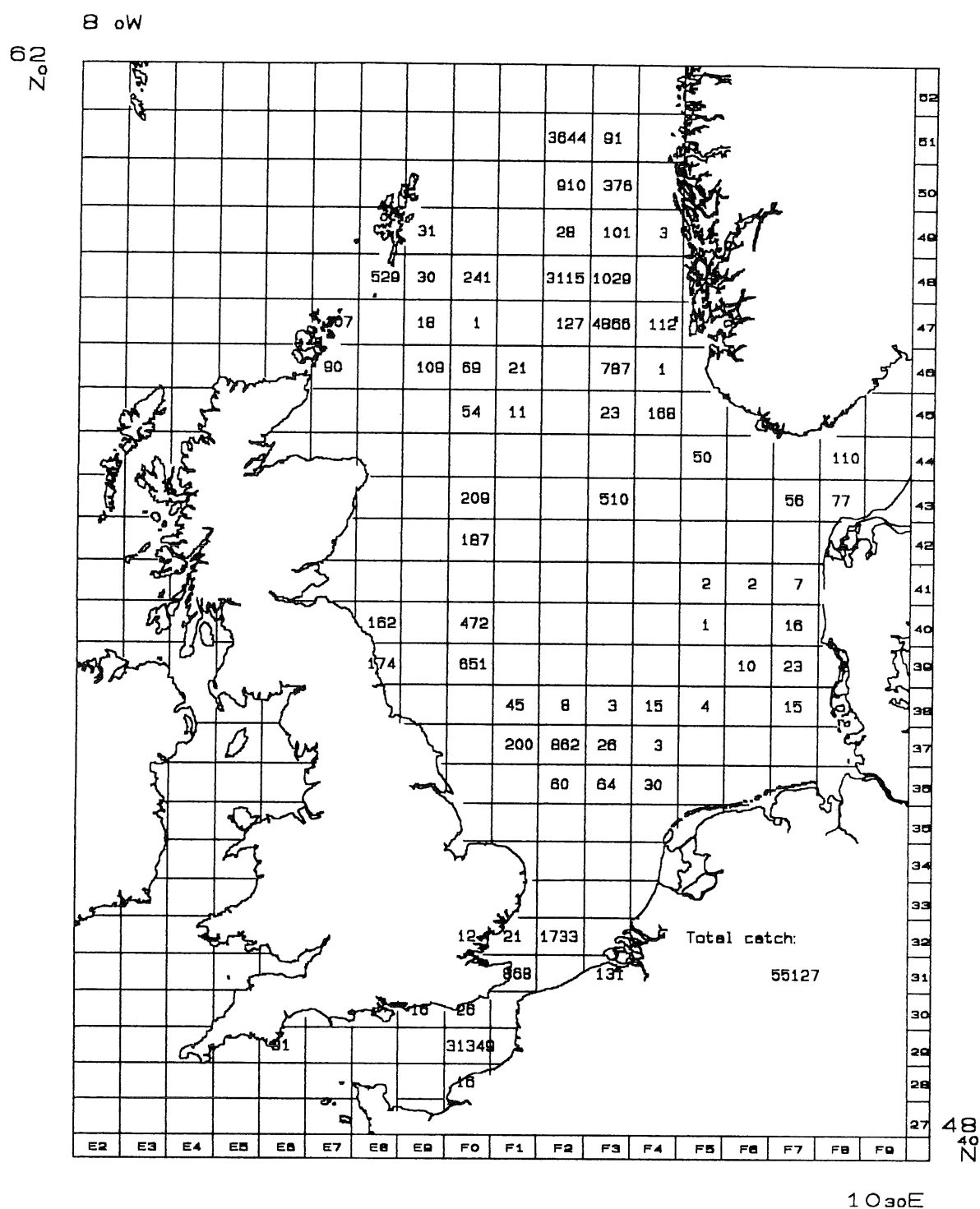
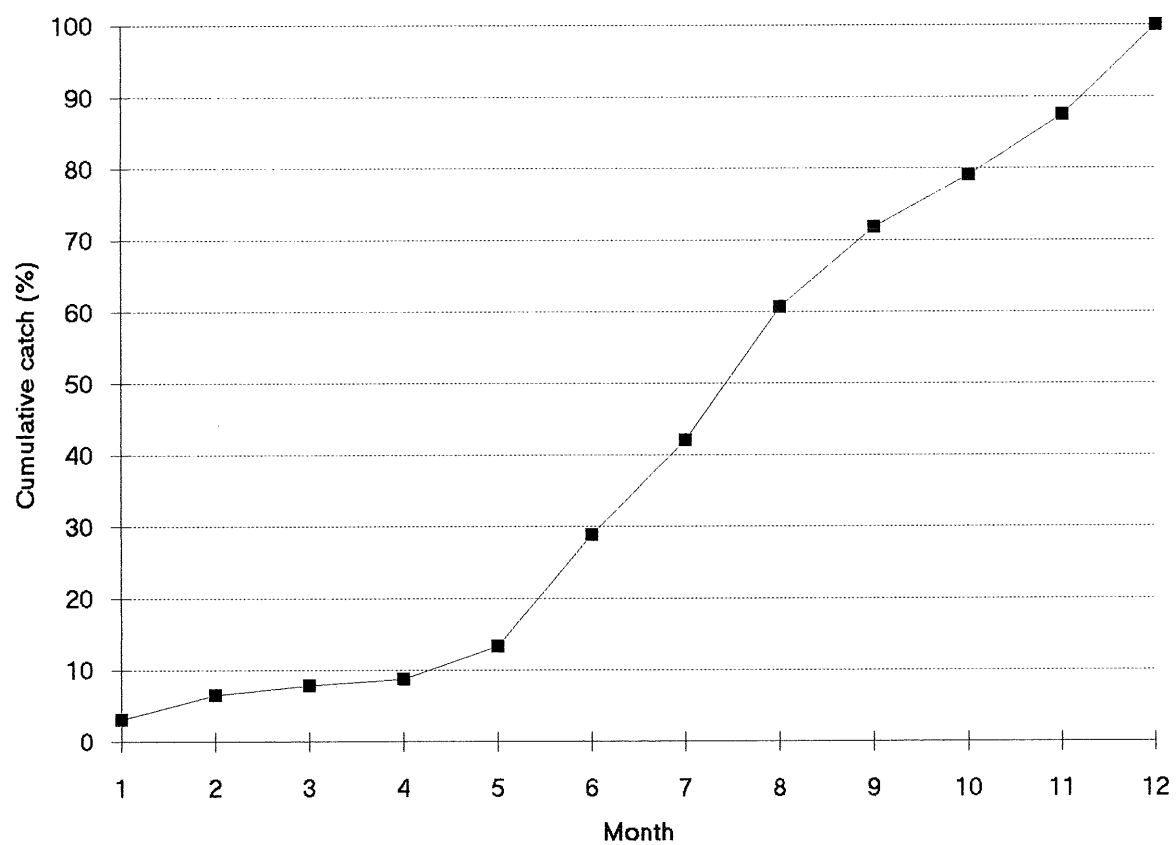


Figure 2.11.13 : North Sea Herring. Cumulative catch by month (1994)



3. HERRING IN DIVISION IIIa AND SUB-DIVISIONS 22-24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1994 and 1995.

1994

ACFM did not recommend a TAC for 1994. ACFM stated that the catches of juveniles, both in the North Sea and Division IIIa, substantially reduced the long-term yield of adult herring and the spawning stock. Therefore, the catches of juveniles should be reduced substantially.

The herring TAC agreed between the EU, Norway and Sweden to be taken in Division IIIa was 148,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

The forecast for 1994 suggested a catch of about 174,000 t, of which 86,000 t would be taken in Division IIIa and 88,000 t in Sub-divisions 22-24 assuming the same distribution of catches and the same fishing mortality in 1994 as in 1990-1992 for the western Baltic spring-spawning herring.

In its management advice ACFM stated that the stock of Western Baltic spring-spawning herring had increased over the last 20 years and that it reached a record high level in 1991. The stock was considered to be within safe biological limits, but the recent year classes were poor and the spawning stock was expected to decrease in 1993. If catches in the range 130,000 to 180,000 t were taken from the stock in 1994, the stock would maintain its present level.

1995

ACFM stated that the state of the stock was uncertain as the information available provides conflicting evidence. Indications were, however, that the stock is well inside safe biological limits and the spawning biomass has increased and the fishing mortality decreased since the late 1970s.

Again in 1994 ACFM did not recommend a TAC for Division IIIa in 1995, but if a precautionary TAC is required, advised that it should not exceed recent catch levels.

The herring TAC agreed between the EU, Norway and Sweden to be taken in Division IIIa was 140,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

As in earlier years no special TAC was set by the International Baltic Sea Fishery Commission (IBSFC) for the Western Baltic Spring-spawning stock in 1993. In the Baltic there is a total TAC for all the Sub-divisions 22-32.

Also in Division IIIa no area TAC was given for this stock.

3.1.2 Introduction to landing statistics

The landings of herring caught in Division IIIa are a mixture of North Sea autumn-spawners and Baltic spring-spawners. Spring-spawning herring in the eastern part of the North Sea, Skagerrak, Kattegat and Sub-Divisions 22, 23 and 24 are considered to be one stock. This section gives the landings of both North Sea autumn-spawners and Baltic spring-spawners, but the stock assessment applies only to the spring-spawners.

3.1.3 Total Landings

Landings from 1985 to 1994 are given in Table 3.1.1. In 1994 the total landings decreased to around 234,000 t in Division IIIa and Sub-divisions 22-24, of which 39,000 t were from the Kattegat, about 129,000 t from the Skagerrak and 66,000 t from Sub-divisions 22-24 (in total a decrease of 60,000 t compared to 1993). In 1994 catches of juvenile herring in Division IIIa have been reduced, which could be seen in conjunction with an increased sprat and sandeel fishery in this division. This year the sprat dominated the mixed clupeoid landings especially in the second half of the year.

The data on landings has been improved since 1993. The Swedish landings from the Skagerrak for industrial purposes have been sampled for quarters 2 and 3. The Norwegian landings from the Skagerrak were not sampled and therefore samples from the adjacent area in the North Sea were used (see Section 3.2).

Misreporting of fishing grounds still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea in quarters 1, 2 and 4. These landings are included in the figures for the North Sea.

The herring catches in Division IIIa are taken mainly in three types of fisheries (see also Anon. 1992b), viz:

A directed fishery for herring (fleet C) in which trawlers (with 32 mm mesh size) and purse seiners participate

The **"Mixed clupeoid fishery" (fleet D)** is carried out under a special "Sprat" TAC for all species caught in this fishery. Danish boats are obliged to use a 32 mm mesh (since 1 Jan 1991). The Swedish fishery includes purse seiners fishing for sprat along the coast and trawlers using small-meshed gear (less than 32 mm). The Norwegian fishery is a purse seine sprat fishery for the canning industry.

Catches of herring also occur as by-catches in other fisheries (fleet E), such as the Norway pout and sandeel

fisheries. This fleet also include some by catches in fleet C.

Attempts have been made to separate the landings of these fisheries. The category "Mixed clupeoids" only refers to Denmark since it was not possible to separate the Norwegian and Swedish "Mixed" landings from other industrial landings. All Swedish landings for industrial purposes are counted under "Landings for industrial purposes" and the Norwegian landings are under "Landings for Human consumption". The landings in the different fisherys for the period 1991-1994 in thousands of tonnes are shown in the text table below.

	Human consump- tion	Mixed clupeoids	Landings for oil and meal	Total
1991				
Kattegat	32	13	24	69
Skagerrak	62	6	54	122
Div.IIIa	94	19	78	191
1992				
Kattegat	24	11	24	59
Skagerrak	75	14	79	168
Div.IIIa	99	25	103	227
1993				
Kattegat	18	12	16	46
Skagerrak	94	15	60	169
Div.IIIa	112	27	76	215
1994				
Kattegat	18	8	12	38
Skagerrak	81	5	43	129
Div.IIIa	99	13	55	167

In Sub-divisions 22-24 all catches are taken in a directed fishery for herring which is treated in this section as one fleet.

The landings from this stock could therefore be split into four components:

- C: Human consumption fleet in Division IIIa.
- D: Mixed clupeoid fleet in Division IIIa.
- E: Landings for industrial purposes in Division IIIa.
- F: Landings from Sub-Divisions 22 - 24.

In the text table below the 1994 landings are given in thousands of t by fleet and quarter.

Quart/ Fleet	Fleet C	Fleet D	Fleet E	Fleet F	Total
1	7.3	6.3	8.0	22.6	44.2
2	16.7	3.1	11.1	27.0	57.9
3	51.4	0.9	19.3	6.0	77.6
4	24.0	2.6	17.2	10.8	54.6
Total	99.4	12.9	55.6	66.4	234.3

3.2 Catch in Numbers and Mean Weight at Age

The sampling intensity of the landings increased in 1994 and the Swedish catches from the Skagerrak for industrial

purposes has been sampled in the second half of the year for the first time. A comparison of species composition in industrial landings in the second half of the year indicated that the Danish species composition in the mixed clupeoid fishery was similar to the species composition in the Swedish industrial landings in the same quarters. The species composition in the Danish mixed clupeoid fishery for the first half of the year was therefore used to estimate the amount of herring in Swedish industrial landings from the Skagerrak in these quarters. Swedish age compositions for human consumption were applied, as the sampling in the second half of the year showed about the same age compositions as in the samples from industrial landings. The sampling of the human consumption landings were generally acceptable with the exception of sampling in the second quarter in the Skagerrak and Western Baltic where the age composition from the first quarter was applied. The landings from Sub-division 23, the Sound, were included in the landings from Sub-division 24.

The Norwegian landings from the Skagerrak were not sampled at all. These landings are mainly taken in the most western part of the Skagerrak and therefore samples from the adjacent area in the North Sea were used to estimate the numbers caught by age.

The Danish sampling programme in 1994 was as in 1993 considered to be at an acceptable level. In Division IIIa, landings were sampled in all quarters.

In Division IIIc (The Sound) no samples from commercial landings were taken. The total landing of 1,800t was converted into landings by age using the age composition as in Sub-division 24.

The landings in Sub-divisions 22-24 were sampled by Poland, Sweden, Germany and Denmark. Based on these data the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-divisions 22, 23 and 24 by the fleets listed in Section 3.1.3 were compiled and are shown in Tables 3.2.1-3.2.3.

3.3 Stock Composition

3.3.1 Spring-spawners in the North Sea

The separation of catches from the NE North Sea into spring- and autumn-spawners is described in Section 2.2.3. The total amount of spring spawners of Division IIIa-Baltic origin taken in the North Sea was estimated to be 13,2000 t in the 1994 catches. Table 2.2.3 presents numbers and mean weights at age.

3.3.2 Stock Composition in Division IIIa

The mixing of spring- and autumn-spawning herring has been described in earlier reports of this Working Group (Anon., 1990b). Landings in Division IIIa were allocated to spawning stock using a combination of modal length

analysis and mean numbers of vertebrae (Anon, 1992b). The split is based mainly on the Swedish samples of vertebrae counts.

The resulting split is summarised below:

Age Grp	Quarter	Skagerrak		Kattegat	
		Spring spawners	Autumn Spawners	Spring Spawners	Autumn Spawners
0	All	%	100%	0%	100%
1	1	0%	100%	0%	100%
	2	0%	100%	0%	100%
	3	0%	100%	0%	100%
	4	0%	100%	0%	100%
2	1	0%	100%	0%	100%
	2	0%	100%	35%	65%
	3	13%	87%	90%	10%
	4	0%	100%	100%	0%

All landings from Sub-divisions 22-24 are assumed to be Baltic spring-spawners.

Based on the above proportions, the catches in number and mean weight by age group for spring- and autumn-spawning herring in each of the three fisheries in Division IIIa are given in Tables 3.3.1 - 3.3.5. The landings of spring spawners taken in Division IIIa in 1994 were thus estimated to be about 84,000 t (Tables 3.3.5 and 3.3.8) compared to about 80,000 t in 1993 and 75,000 t in 1992.

The landings of North Sea autumn-spawners in Division IIIa amounted to 86,000 t in 1994 (Tables 3.3.6. and 3.3.9) which are very close to the projected catch based on a *status quo* fishing mortality option in the 1994 forecast (Anon,1994a). The 1994 landing represents a significant reduction compared to 1992 and 1993 when 152,000 t and 132,000 t were taken.

Table 3.3.5 gives the total catch in number-at-age of Division IIIa/Baltic spring spawners in the North Sea, Division IIIa and in Sub-divisions 22-24 by quarter for 1994. The totals for 1987-1994 are given in Table 3.3.8.

Table 3.3.7 gives the total landings in numbers and mean weight at age by fleet of the Division IIIa/Baltic spring-spawning herring caught in the North Sea, Division IIIa and in Sub-Division 22-24 in 1994. The total landings in 1994 were 164 000 t, ie close to the 1993 landings of 170 000 t.

3.4 Quality of Catch and Biological Sampling Data

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Divisions IIIa, IIIb and IIIc were 234,000 t, from which 296 samples were taken and 51,000 herring were measured and 15,000 aged. The sampling intensity by quarter over all landings is acceptable with a mean of

more than one sample per 1000 t landed, but the distribution over seasons, areas and fishing fleets needs to be improved.

Sampling of the Danish catches for industrial purposes was nearly at the same level as in previous years. The number of samples and number of fish investigated were considered to be at a reasonable level. Again in 1994 there have been difficulties in getting samples from the Danish human consumption fishery in the the Skagerrak.

There is uncertainty about where the Danish catches for human consumption reported in Division IIIa (quarters 1, 2 and 4) were actually taken. Information indicates that these landings were most likely to have been taken in the North Sea and these landings were therefore transferred to the North Sea.

In 1994 Sweden established a new sampling programme for the industrial landings from Division IIIa. In the second half of the year nearly 100 samples from this fishery were taken. This sampling level met the requirement of the agreed level of one sample per 1000 t landed. Swedish sampling in the Kattegat was adequate but sampling of landings by Swedish vessels in Denmark still needs to be improved.

Norway did not collect any biological samples from the fishery in Division IIIa in 1994. The species composition of these landings is well known but the fishing positions are uncertain. The Norwegian and Danish fishery for human consumption takes place in the area around the border line between the North Sea and Skagerrak and misreportings are known to occur.

Owing to market conditions, introduced technical regulations and quotas, discards occur in the purse seine and some fleets in the trawl fishery in Division IIIa, especially June, July and August. Lack of sampling of discards creates problems which need to be resolved for the assessment.

Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter the coverage of different fisheries, areas and seasons is not adequate.

For reasons discussed in Section 1.8 the Working Group recommends that adequate sampling is conducted for all fisheries in Division IIIa and Sub-divisions 22-24.

3.5 Fishery-Independent Stock Estimates of the Western Baltic Spring-Spawning Stock

3.5.1 Acoustic surveys

3.5.1.1 Summer Acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. As in previous years the survey was conducted by R/V DANA. The echo integration survey covered the North Sea east of 5°E between 57°N and 58°30'N. Acoustic data were collected using a 38 kHz Simrad echosounder with a hull-mounted transducer. The echointegration data were stored by the echo analysis system ECHOANN (Degnbol *et al.*, 1990). Pelagic sampling was carried out mainly by pelagic trawling with a Foto trawl (6 mm in the codend), but also an Expo trawl (16 mm codend) was used on the bottom. The trawl hauls were performed mainly during the night (1600-0600).

The TS relationships used in this survey were:

Clupeids: $TS = 20 \log L \text{ (cm)} - 71.2$
Gadoids: $TS = 20 \log L \text{ (cm)} - 67.5$

A total of 44 trawl hauls were carried out. Further details of the survey are given in Simmonds *et al.* (W.D.1995).

The estimated stock sizes of spring-spawning herring in 1992, 1993 and 1994 are summarized in Tables 3.5.1-3.5.3. The 1994 estimates from the Kattegat were not available at the time of the meeting. Normally the herring in the Kattegat in July are young herring (0-2 ringers) belonging to North Sea autumn-spawners. Therefore they do not contribute to the stock estimate of Baltic spring-spawners. The 1994 survey indicates a very large stock size in the order of 900,000 t compared to 700,000 t in 1992 and 370,000 t in 1993. This large increase is not due to a strong recruitment but rather to an increased estimate of the 3- ringers and older herring. The calculated mean total mortality Z for 2-7 ringers between the 1992 and 1993 surveys is -0.5 and 0.13 between 1993 and 1994. This indicates that there are severe problems concerning these acoustic estimates (see also Section 3.8.1).

3.5.1.2 October acoustic survey in the Western Baltic and the Southern Part of Division IIIa (Kattegat)

The joint Danish-German survey of R/V "Solea" covered the whole of Sub-divisions 22, 23, 24 and the southern part of Division IIIa. The investigations were performed only at night because during daytime the fish were concentrated too close to the bottom. The equipment and methods were the same as in previous years. An EK 500 echosounder (38 kHz) with towed transducer was used and a midwater "Blacksprutte"

trawl, with 10 mm bar length codend, was used for biological sampling.

Sixty sample hauls were made and an area of about 12,000 square nautical miles was surveyed. S_A values for each stratum were converted into fish density using the following TS-length relationships:

Clupeids: $TS = 20 \log L \text{ (cm)} - 71.2$
Gadoids: $TS = 20 \log L \text{ (cm)} - 67.5$

The total number of fish was converted into species and age groups according to the composition in the trawls. The survey results in 1992, 1993 and 1994 are given in Tables 3.5.1-3.5.3.

3.6 Recruitment

3.6.1 General remarks on the 1995 IBTS February survey in Division IIIa

The 1995 survey was carried out over the same time period as in previous years. In spite of bad weather all standard stations were covered. In total 48 hauls were made. The 1994/95 winter was again as mild as the winters 1987/88. The final indices of 1, 2 and 3+ ringed herring are given in Table 3.6.1

3.6.2 Abundance of 1-ringed herring

The index of 1-ringings in 1995 was 7,114. An attempt was made to separate the different length components into spring- and autumn-spawning herring. The separation of 1-ringings into autumn- and spring-spawners was not convincing, but the vertebral counts indicated that North Sea herring were dominant.

3.6.3 Abundance of 2-ringed herring

The final index of 2-ringings in 1995 was 535 which is one of the lowest since 1977. A separation of autumn- and spring-spawners was attempted but the result could not be verified. The vertebral count distribution was unusual with high values at both extremes of the length distribution. The method applied to separate autumn and spring-spawning herring has given robust estimates of the proportions.

3.6.4 Abundance of 3+ ringed herring

The final index of 3+ -ringed herring was 344 which is one of the lowest observed since 1977. The 3-ringings and older are considered to be Western Baltic spawners. However, this survey was not designed to estimate the abundance of adult herring, which are known to be concentrated in the Sound and in Sub-divisions 22-24 at this time of the year.

3.6.5 Abundance indices for Sub-divisions 22-24

Recruitment indices for 0,1-,2-, and 3+ ringed herring from bottom-trawl surveys carried out in November/December each year in Sub-divisions 24 and 22 are given in Tables 3.6.2 to 3.6.3. Combined estimates for the total area are derived by weighting the single survey estimate by the areas of each Sub-division. The resulting index series are shown in Table 3.6.4. The results of the 1993 survey indicate a strong 1993 year class but the 1994 estimate of this year class as 1-ringers is low. The 1993 and 1994 surveys gave very high catches of 3+ herring in both areas and these indices are the highest recorded since 1978. It appears difficult to follow either strong or weak year classes in the time series and the predictive value of this recruitment index is questionable.

3.7 Larvae surveys

No larvae surveys are available.

3.8 Assessment of Western Baltic Spring-Spawning Herring

The group did not carry out a VPA/XSA for Western Baltic Herring but used the ICA program. The ICA-methodology was preferred to the VPA/XSA-methodology for the reasons explained in Section 1.6.

This year, the same sort of problems as last year were encountered when trying to assess the Western Baltic herring stock. The survey indices did not indicate the same development as the data from the commercial fishery is believed to signal. Furthermore, the five survey indices considered showed a somewhat conflicting picture (as will be discussed later), and inconsistencies were also observed within the surveys, e.g. appearance of negative mortality rates, $\ln(\text{Index}(a-1, y-1)/\text{Index}(a, y))$, in a rather un-systematic pattern. The overall result of the ICA-analysis was a decreasing fishing mortality and an increasing stock during the last six years. The Working Group felt that both the data on the commercial fishery and the survey data were questionable. The Working Group discussed the possible use of effort data from the commercial fishery. Although fishing effort and fishing mortality are supposed to be related in a rather complex way for pelagic fisheries, the Working Group felt it would be justified to spend some time on studying effort data from the commercial fishery.

Below follows a description of the ICA assessment and a discussion of the results. Due to the dubious quality of the assessment, the Working Group decided not to make predictions.

3.8.1 ICA for Western Baltic Herring.

Catch at age and survey indices used as input data to ICA are shown in Tables 3.8.1-3.8.6. It should be noted that some input data cover the time period from 1975 to 1994, but that the splitting of the Divisions IIIa/IVa herring stock started only in 1983. Furthermore, the Danish sampling system was changed in 1988, and catch data before 1988 are considered questionable. Some runs were made in which data before 1988 were excluded from the analysis.

Natural mortality, maturity ogive, proportions of F and M before spawning are all assumed to remain constant from year to year. M is assumed to be 0.2 per year, F-prop .1 and M-prop 0.25 for all age groups. The maturity ogive is:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	.2	.75	.9	1	1	1	1

No multispecies VPA has been executed by the Baltic Multispecies Working Group for the Western Baltic and Kattegat area. The same M's as last year were used. Five survey indices (and subsets of surveys) were considered for tuning the ICA for the Western Baltic Spring-Spawning Herring:

INDEX 1: 1980-95: IBTS IIIa, Age groups 2 and 3+.

INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age groups 0-3+.

INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age groups 0-3+.

INDEX 3a: 1979-94: German Bottom Trawl Survey combined for Sub.Div. 22 and 24, A.gr. 0-3+.

INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 2-8.

INDEX 4a: 1989-94: Acoustic survey in IIIa+IVaE using only the data from IVa (E), Age groups 2-8.

INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age groups 0-8

As the indices 2 and 3 basically measure the same stock with the same methodology, it was considered natural to test a combination of the two indices (Index 3a). Some doubts were expressed about the values of index 4 data from Division IIIa, and it was decided to make a run where only data from the North Sea were used (Index 4a). However, this approach was also questioned, as it is not known if the proportion of the western Baltic herring stock migrating into the North Sea is constant over years. No biomass index was used, as the Working Group decided that age-structured indices should be used whenever available. Age-aggregated indices should be used only when the age disaggregated indices are not available.

In all ICA-runs the following parameters were kept constant:

- Weighting factor (or lambda) (= 1.0) to all indices.
- The linear model was used for all indices.
- The range of years used in separable constraint: 6
- The reference F was given for age 4, and the selection for oldest age was 1

Eleven runs were made with different combinations of indices as given in the text table. The eleven runs were compared by using the estimates and confidence limits of the reference F in 1994 and the SSB in 1994. The results of the comparative runs are given in the text table:

F and SSB in 1994 from ICA					
Run No.	Index	Mean F 1994	Lower L.	Upper L.	SSB 1994
1	All indices combined	0.20	0.16	0.25	703
2	1 IBTS IIIa	0.77	0.45	1.31	199
3	2 German Btm Tr. Sur. 24	0.10	0.07	0.16	1243
4	3 German Btm Tr. Sur. 22	0.27	0.20	0.38	485
5	4 Acous. sur.IIIa+IVaE	0.04	0.02	0.07	3082
6	4a Acous. sur. IVaE	0.22	0.15	0.34	587
7	5 Acous. sur.in 22-24	0.15	0.10	0.24	877
8	Indices 2,3,4,5	0.16	0.13	0.20	861
9	Indices 2,3,4,5 (1988-94)	0.07	0.05	0.11	1817
10	4a Acous. sur. IVaE (1988-94)	0.24	0.16	0.35	563
11	Indices 2,3 combined	0.11	0.08	0.15	1125

As can be seen, index 1 (IYFS IIIa, Age groups 2 and 3+) yielded values of F and SSB in 1994 which are not in line with the other indices, and which were considered unrealistic. Actually, none of the indices showed a convincing relationship with estimated stock numbers, but some indices produced unrealistic results. Index 1 was really an outlier and it was excluded. Consequently, it was excluded from the analysis. Runs giving a SSB above 1 million tonnes were also considered highly unrealistic. Actually only runs 4, 6 and 10 gave SSB values in the range considered realistic by the working group.

As a basis for the presentation of the assessment run no. 1 was selected, as this run contains the full set of survey indices. Inputs from ICA Run No. 1 are shown in Tables 3.8.7-15. The key results of the ICA analysis are also shown in Figures 3.8.1-3.8.3. Figures 3.8.4-3.8.8 show the tuning diagnostics for each combination of survey index and age group. The graph "stock numbers" (see e.g. Figure 3.8.4a, which shows the IYFS (or IBTS) in IIIa age group 2), indicates to what degree the survey index reflects the stock numbers estimated from ICA. The vertical lines indicate the stock number predicted from the index, plus/minus the standard deviation of the stock estimate. The graph "Catchability" shows the relationship between index and stock numbers estimated from ICA. This relationship is supposed to be a straight line through (0,0). The two lower graphs show the corresponding residuals, which are supposed to be randomly distributed around the X-axis. Inspecting the 25 graphs of tuning diagnostics reveals that none of them are really convincing. Actually, at least one of them should by chance have been "nice", but even that was not the case.

To illustrate the problems encountered when attempting to analyse the survey data, the indices for the years 1989 to 1994 are shown in Figure 3.8.9, which compares the alternative indices. Had the indices been consistent with each other, they should all have indicated the same overall recruitment picture. In order to make the indices compatible, they have been converted into relative values, that is as percentages of the maximum value during the seven years ($\text{Relative Index} = 100 \cdot \text{Index} / \text{Maximum}\{\text{Index}_{1989}, \dots, \text{Index}_{1994}\} \%$). Thus, the bars within a year group in Figure 3.8.9 should have approximately the same height if the surveys showed the same overall picture. As can be seen, the surveys show quite different overall pictures, and the working group remains concerned about the use of these survey data. Bearing in mind that many mortality rates estimated from survey indices ($\ln(\text{Index}(a-1, y-1) / \text{Index}(a, y))$) were negative in a non-systematic way, this result is perhaps not surprising.

3.8.2 Discussion of assessment of Western Baltic Herring.

The sum of squares of deviations between estimated and observed indices (SSQ) as a function of the reference F (in 1994) for run No. 1 (all indices used for all years available) are shown in Figure 3.8.1. The optimum reference F should be the one with the minimum index SSQ. As can be seen, there is no clear indication of the best reference F in 1994. Only index 3 has a conspicuous minimum, whereas the other curves are rather flat.

Figure 3.8.2 shows the stock summary from ICA. It shows an increasing trend in stock biomass, from about 200,000 t in 1975 to 900 000 t in 1994. Fishing mortality showed the opposite trend, decreasing from about 1.0 in

the mid seventies to about 0.18 in 1994. The trend in landings is somewhat in contradiction with the trends in F and stock biomass, as landings show an increasing trend until around 1989, and a slight decrease until 1994. Proportionally the decrease in landings is much smaller than the decrease in fishing mortality.

The approximate confidence bands (log-transformed mean \pm std.dev) of F were estimated to be [0.10, 0.57] for Run No.1 (see Table 3.8.10), so the reduction of F from 0.21 in 1993 to 0.17 in 1994 is not significant. However, this estimate of confidence limits does not account for a possible bias in the data. Therefore, it is difficult to discuss the reasons for the smaller terminal F this year. As can be seen from the stock summaries (Table 3.8.9 or Figure 3.8.2), the F-at-age has undergone a dramatic change during the time series of the analysis. From very high values in the eighties of around 1.0 for ages 4-8 fishing mortalities for these age groups dropped to a low level of around 0.25 in the nineties. This feature of F should be seen in conjunction with the fact that the catch-at-age-pattern has undergone a dramatic change (see Table 3.8.1). Catches in the eighties were dominated by 0-3 groups but in the nineties, the bulk of the landings stems from the older age groups.

Whether in fact there has been such a dramatic change in the fishing pattern was discussed by the Working Group. The dominance of older fish in the catch in recent years can also be explained by a series of high recruitments. It was suggested that the apparent change in the fishing pattern was not real, but that it was caused by an inappropriate sampling procedure (raising) used in the eighties. Before 1990 the Danish sampling was not stratified on fleets. In 1990 samples were sampled and raised for the human consumption fleet, the mixed clupeoid fishery and the other industrial fishery for reduction. Before 1990 the samples might have overestimated the smaller size groups in Division IIIa believed to be autumn-spawners, because most samples were taken from small vessels participating in the mixed fishery. Small herring caught in the human consumption fishery were separated on board the vessels (using sorting machines), and were landed for reduction. These by-catches of small herring were probably not adequately covered by the sampling programme, and most often they were assumed to be of the same size as those in the mixed fishery. There is some suspicion that in fact they were bigger than those of the mixed fishery.

Another factor worth mentioning is that major landings of herring for reduction purposes from Division IIIa are not covered by age composition samples. This applies in particular to large Swedish industrial landings before 1994, for which Danish age compositions have been applied. Whether this procedure is appropriate is not known. The sampling in 1994 suggests that the age composition in the Swedish industrial landings is different from the Danish ones, with a much higher abundance of adult herring. In 1994 the Swedish age

composition in the human consumption fishery and in the industrial landings were about the same in the second half of the year.

The apparent increase in stock biomass and reduction in fishing mortality cannot be explained by a change in the fishing intensity. The explanation may be found in the survey indices. None of the surveys covered the entire distribution area of the stock. Therefore, none of the surveys gave an estimate of the entire stock. If, however, the surveys estimated a constant proportion of the stock, they were still useful as indices. But if the estimated proportion varied from year to year, this would introduce a bias. Being a migratory species, it could be suspected that the proportion of the stock in each survey area varied from year to year.

The Working Group found it difficult to accept the unexpected results of the assessment, and it was decided not to present any assessment. The results in Tables 3.8.7-15 and Figures 3.8.1-8 are shown only to illustrate the problems encountered. Consequently, no attempt to predict the catches for the Western Baltic herring was made.

3.8.3 Management considerations for Western Baltic Herring

Although the group did not feel that it could carry out an analytical assessment, some qualitative statements can be made about the state of the Western Baltic Herring stock:

The stock appears not to be in immediate danger of collapse. It is more likely that the stock is lightly exploited and that the spawning stock biomass is at a high level. Looking at the catch at age (see Figure 3.8.10) there are indications that the younger age groups have made up a smaller proportion in recent years compared to earlier years (before 1989). To what degree this picture is real or caused by inadequate sampling in earlier years is not known. Looking at the landings (see Figure 3.8.11), it can be seen that catches have been higher in the past, but there is no indication that the recent reduction in landings is caused by increased fishing mortality. Thus the Working Group believes that the reduction in landings is due to reduced fishing activity. Only one of the survey indices (IBTS in Division IIIa) indicated a high fishing mortality. This survey is carried out in February and is not designed for estimation of the Western Baltic herring stock. By that time of the year the Western Baltic herring is supposed to be in Sub-divisions 22 and 24 on their way to the spawning grounds off Rügen. Thus, if the combined data from five surveys tell anything, they indicate that fishing mortality is low and stock size is high. However, the group dares not quantify this statement. To conclude, the group is not overwhelmingly concerned about the

state of the Western Baltic herring stock. It is most probably in a healthy state.

Table 3.1.1 HERRING in Division IIIa and Sub-divisions 22-24, 1985-1994. Landings in '000 tonnes by country. (Data provided by Working Group members 1995). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994*
Skagerrak										
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9
Faroe Islands	0.5	0.5								
Norway	4.5	1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0
Kattegat										
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0
Sub. Div. 22 + 24										
Denmark	15.9	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6
Sub. Div. 23										
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4

* Preliminary data.

Table 3.2.1 Skagerrak 1994

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.04	23.2	81.28	15.2	30.35	16.0	111.67	15.4
2	25.55	54.7	0.24	55	34.07	54.7	59.86	54.7
3	5.94	87.5			7.85	87.5	13.79	87.5
4	1.18	107.5	0.08	71	1.55	107.5	2.81	106.5
5	0.34	141.1			0.46	141.1	0.80	141.1
6	0.14	160.5			0.28	167.4	0.42	165.1
7	0.03	179.3			0.03	179.3	0.06	179.3
8+	0.03	177.0			0.03	177.0	0.06	177.0
TOTAL	33.25		81.60		74.62		189.47	
Land. (SOP)(t)	2,126		1,254		3,324		6,705	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	16.20	44.0	82.06	16.3	256.45	16.3	354.71	17.6
2	53.92	94.3	1.68	57.9	30.08	65.7	85.68	83.5
3	30.74	124.2	0.17	72.0	11.60	101.2	42.51	117.8
4	10.51	143.0			3.89	134.3	14.40	140.6
5	9.92	168.5			2.74	166.2	12.66	168.0
6	5.42	179.3			1.25	181.8	6.67	179.8
7	1.33	204.4			0.49	195.8	1.82	202.1
8+	0.69	197.0			0.27	190.4	0.96	195.1
TOTAL	128.73		83.91		306.77		519.41	
Land. (SOP)(t)	14,168		1,447		8,684		24,300	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			27.90	25.0	165.06	9.0	192.96	11.3
1	142.12	93.2	0.58	69.0	27.26	67.3	169.96	89.0
2	96.48	124.7	0.29	60.0	30.88	113.9	127.65	121.9
3	53.82	140.3			23.18	127.5	77.00	136.4
4	47.21	156.2			27.18	146.8	74.39	152.8
5	22.69	159.2			17.13	163.6	39.82	161.1
6	14.89	200.7			5.32	178.4	20.21	194.8
7	2.72	207.8			2.66	195.3	5.38	201.6
8+	0.66	206.0			1.32	241.1	1.98	229.4
TOTAL	380.58		28.77		300.00		709.35	
Land. (SOP)(t)	47,499		755		18,374		66,628	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	6.97	37.2	46.13	22.8	167.61	17.6	220.71	19.3
1	119.92	93.6	0.61	49.0	73.77	90.3	194.30	92.2
2	25.07	132.0			15.73	128.9	40.80	130.8
3	8.42	156.4			4.72	154.0	13.14	155.5
4	2.64	186.7			0.99	199.3	3.63	190.2
5	1.07	201.0			0.59	210.5	1.66	204.4
6	1.09	207.9			0.37	220.1	1.46	211.0
7	0.25	227.7			0.18	227.7	0.43	227.7
8+	0.32	276.5			0.22	276.5		
TOTAL	165.75		46.74		264.18		476.13	
Land. (SOP)(t)	17,196		1,082		12,879		31,007	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	6.97	37.2	74.03	23.6	332.67	13.4	413.67	15.6
1	278.28	90.5	164.53	16.1	387.83	33.9	830.64	49.3
2	201.02	108.5	2.21	57.9	110.76	84.7	313.99	99.8
3	98.92	133.5	0.17	72.0	47.35	117.1	146.44	128.1
4	61.54	154.4	0.08	71.0	33.61	145.1	95.23	151.0
5	34.02	163.1			20.92	164.8	54.94	163.7
6	21.53	195.4			7.23	180.7	28.76	191.7
7	4.33	207.7			3.36	196.9	7.69	203.0
8+	1.70	215.0			1.84	236.9	3.54	226.4
TOTAL	708.31		241.02		945.57		1894.90	
Land. (SOP)(t)	80,989		4,538		43,262		128,789	

Table 3.2.2 Kattegat 1994

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	14.88	24.0	141.39	17.9	105.08	18.6	261.35	18.5
2	13.40	68.7	42.49	49.8	22.92	58.5	78.81	55.5
3	18.87	96.7	6.10	59.3	10.49	91.3	35.46	88.6
4	7.64	120.4	0.57	45.0	1.77	117.7	9.98	115.6
5	3.44	156.2			0.79	134.6	4.23	152.2
6	2.92	147.8			0.49	166.0	3.41	150.4
7	0.55	187.6			0.11	202.4	0.66	190.0
8+	0.31	223.9			0.11	196.9	0.42	216.6
TOTAL	62.02		190.55		141.75		394.32	
Land. (SOP)(t)	5,165		5,034		4,694		14,892	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	4.07	36.5	47.76	17.9	14.29	22.8	66.12	20.1
2	12.21	64.1	14.35	49.8	7.91	66.9	34.47	58.8
3	10.09	78.9	2.06	59.3	7.85	80.1	20.00	77.3
4	2.80	91.5	0.19	45	2.72	96.1	5.71	92.1
5	1.95	123.4			1.82	118.3	3.77	121.0
6	1.12	128.1			1.50	126.9	2.62	127.4
7	0.69	150.6			0.86	138.3	1.55	143.8
8+	0.47	147.7			0.72	147.7	1.19	147.7
TOTAL	33.42		64.36		37.65		135.43	
Land. (SOP)(t)	2,542		1,700		2,375		6,618	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	1.57	13.1	9.42	10.9	0.99	16.8	11.98	11.7
1	8.23	93.2	0.10	43	4.50	63.8	12.83	82.5
2	7.85	116.0			2.53	87.7	10.38	109.1
3	8.03	130.5			1.49	124.2	9.52	129.5
4	4.45	141.2			0.60	174.1	5.05	145.1
5	1.86	169.8			0.36	194.6	2.22	173.8
6	0.72	204.8			0.16	233.1	0.88	210.0
7	0.25	181.2			0.06	253.7	0.31	194.3
8+	0.24	132.0			0.04	239.2	0.28	146.3
TOTAL	33.20		9.52		10.73		53.45	
Land. (SOP)(t)	3,915		107		947		4,968	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.55	22.9	65.95	19.2	41.08	21.3	116.58	20.2
1	26.07	78.5	5.19	40.4	37.45	71.7	68.71	71.9
2	10.28	109.0			5.82	85.8	16.10	100.6
3	7.57	144.7			1.36	130.7	8.93	142.6
4	4.41	179.6			0.30	154.3	4.71	178.0
5	4.03	189.7			0.01	249.1	4.04	189.9
6	1.66	205.3			0.02	214.5	1.68	205.5
7	1.15	235.7			0.01	252.8	1.16	235.8
8+	0.57	284.1			0.01	301.0		
TOTAL	65.30		71.14		86.05		221.91	
Land. (SOP)(t)	6,811		1,476		4,294		12,416	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	11.12	21.5	75.37	18.2	42.07	21.2	128.56	19.4
1	53.26	62.3	194.44	18.5	161.31	32.6	409.01	29.8
2	43.74	85.4	56.84	49.8	39.18	66.1	139.76	65.5
3	44.55	106.9	8.16	59.3	21.20	92.0	73.91	97.4
4	19.31	134.5	0.76	45.0	5.38	115.1	25.45	127.7
5	11.28	164.7			2.98	132.5	14.26	158.0
6	6.42	165.6			2.17	144.4	8.59	160.3
7	2.65	198.2			1.03	152.1	3.68	185.4
8+	1.59	209.0			0.88	159.2	2.47	191.3
TOTAL	193.93		335.57		276.19		805.69	
Land. (SOP)(t)	18,433		8,317		12,309		39,059	

Table 3.2.3

Sub-Division 22 - 24 in 1994

Landings in numbers (millions) and mean weight (g) at age by Sub-Divisions.

	Sub-Division 22*		Sub-Division 23		Sub-Division 24		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	14.77	20.2	0.43	19.6	13.07	19.0	28.27	19.7
2	14.48	46.1	0.12	39.4	6.13	40.2	20.73	44.3
3	6.68	55.8	1.16	87.2	35.83	83.2	43.67	79.1
4	2.19	74.7	1.61	110.3	46.19	107.6	49.99	106.2
5	2.79	101.4	0.96	149.1	29.06	140.7	32.81	137.6
6	3.88	169.7	0.80	159.5	23.52	155.1	28.20	157.2
7	4.75	178.7	0.13	173.9	4.84	173.2	9.72	175.9
8+	4.47	196.6	0.13	213.4	3.99	208.2	8.59	202.2
TOTAL	54.01		5.36		162.63		222.00	
Land. (SOP)(t)	4,172		615		17,852		22,640	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight			Numbers	Weight
0								
1	34.86	20.2			2.70	18.0	37.56	20.0
2	33.78	46.3	0.15	51.3	6.86	46.9	40.79	46.4
3	14.79	60.2	1.61	73.3	46.72	72.7	63.12	69.8
4	15.75	83.8	1.01	78.8	36.61	85.4	53.37	84.8
5	16.48	101.4	0.64	93.3	27.42	109.2	44.53	106.1
6	13.48	129.7	0.79	92.5	25.99	115.5	40.26	119.8
7	12.73	161.7	0.33	99.0	10.71	128.0	23.77	145.7
8+	9.56	180.1	0.19	90.2	5.60	122.8	15.34	158.1
TOTAL	151.43		4.71		162.61		318.75	
Land. (SOP)(t)	11,678		387		14,948		27,013	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight			Numbers	Weight
0	100.17	12.9					100.17	12.9
1	6.29	50.6	0.05	43.5	2.85	44.6	9.19	48.7
2	12.39	71.5	0.39	53.4	5.37	53.3	18.15	65.7
3	9.94	80.8	0.85	58.9	11.78	63.3	22.57	70.9
4	3.84	98.5	0.81	59.4	5.81	65.9	10.46	77.4
5	2.04	121.9	0.56	55.0	1.97	63.4	4.57	88.5
6	0.55	81.6	0.10	69.5	0.43	94.1	1.08	85.5
7	0.41	157.5	0.10	64.0	0.33	80.8	0.84	116.3
8+			0.03	103.0	0.10	119.7	0.13	116.3
TOTAL	135.63		2.88		28.64		167.15	
Land. (SOP)(t)	4,037		168		1,746		5,950	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight			Numbers	Weight
0	100.59	13.0	0.10	9.7	1.72	10.7	102.41	12.9
1	8.51	47.6	0.83	40.1	11.93	43.4	21.27	45.0
2	15.67	68.0	1.04	65.1	7.46	66.0	24.17	67.2
3	12.42	80.7	2.23	91.3	17.00	95.9	31.65	89.6
4	5.64	97.5	1.91	111.6	14.69	103.4	22.24	102.6
5	2.57	123.6	0.66	105.1	5.70	115.6	8.93	117.1
6	0.78	98.1	0.45	114.2	3.25	126.5	4.48	120.3
7	0.50	160.8	0.05	233.5	0.23	233.5	0.78	187.2
8+	0.01	208.5	0.08	189.3	0.32	189.3	0.41	189.8
TOTAL	146.69		7.35		62.30		216.34	
Land. (SOP)(t)	4,804		667		5,361		10,832	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight			Numbers	Weight
0	200.76	12.9	0.10	9.7	1.72	10.7	202.58	12.9
1	64.43	26.8	1.31	33.4	30.55	30.8	96.29	28.2
2	76.32	54.8	1.70	59.4	25.82	52.1	103.83	54.2
3	43.83	70.0	5.85	80.8	111.33	78.6	161.02	76.4
4	27.42	88.0	5.34	97.1	103.30	96.8	136.06	95.0
5	23.88	105.5	2.82	107.5	64.15	122.6	90.85	117.7
6	18.69	135.3	2.13	121.1	53.19	133.5	74.01	133.6
7	18.39	166.0	0.62	121.5	16.11	142.1	35.12	154.3
8+	14.04	185.4	0.42	147.7	10.01	158.9	24.47	173.9
TOTAL	487.76		20.30		416.18		924.24	
Land. (SOP)(t)	24,690		1,837		39,908		66,435	

* German landings from Sub-Division 22 and 24 are listed under Sub-Division 22.

Table 3.3.1 Skagerrak 1994 North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.04	23.2	81.28	15.2	30.35	16.0	111.67	15.4
2	25.55	54.7	0.24	55	34.07	54.7	59.86	54.7
3								
4								
5								
6								
7								
8+								
TOTAL	25.59		81.52		64.42		171.53	
Land. (SOP)(t)	1,399		1,249		2,348		4,995	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	16.20	44.0	82.06	16.3	256.45	16.3	354.71	17.6
2	53.92	94.3	1.68	57.9	30.08	65.7	85.68	83.5
3								
4								
5								
6								
7								
8+								
TOTAL	70.12		83.74		286.53		440.39	
Land. (SOP)(t)	5,795		1,435		6,158		13,388	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			27.90	25.0	165.06	9.0	192.96	11.3
1	142.12	93.2	0.58	69.0	27.26	67.3	169.96	89.0
2	12.54	124.7	0.04	60.0	4.01	113.9	16.59	121.9
3								
4								
5								
6								
7								
8+								
TOTAL	154.66		28.52		196.33		379.51	
Land. (SOP)(t)	14,806		740		3,778		19,324	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	6.97	37.2	46.13	22.8	167.61	17.6	220.71	19.3
1	119.92	93.6	0.61	49.0	73.77	90.3	194.30	92.2
2	25.07	132.0			15.73	128.9	40.80	130.8
3								
4								
5								
6								
7								
8+								
TOTAL	151.96		46.74		257.11		455.81	
Land. (SOP)(t)	14,800		1,082		11,645		27,527	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	6.97	37.2	74.03	23.6	332.67	13.4	413.67	15.6
1	278.28	90.5	164.53	16.1	387.83	33.9	830.64	49.3
2	117.08	97.0	1.96	57.6	83.89	75.4	202.93	87.7
3								
4								
5								
6								
7								
8+								
TOTAL	402.34		240.52		804.38		1447.24	
Land. (SOP)(t)	36,800		4,505		23,929		65,234	

Table 3.3.2 Kattegat 1994

North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	14.88	24.0	141.39	17.9	105.08	18.6	261.35	18.5
2	13.40	68.7	42.49	49.8	22.92	58.5	78.81	55.5
3								
4								
5								
6								
7								
8+								
TOTAL	28.28		183.88		128.00		340.16	
Land. (SOP)(t)	1,278		4,647		3,298		9,222	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	4.07	36.5	47.76	17.9	14.29	22.8	66.12	20.1
2	7.94	64.1	9.33	49.8	5.14	66.9	22.41	58.8
3								
4								
5								
6								
7								
8+								
TOTAL	12.01		57.09		19.43		88.53	
Land. (SOP)(t)	658		1,320		670		2,647	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	1.57	13.1	9.42	10.9	0.99	16.8	11.98	11.7
1	8.23	93.2	0.10	43	4.50	63.8	12.83	82.5
2	0.79	116.0			0.25	87.7	1.04	109.2
3								
4								
5								
6								
7								
8+								
TOTAL	10.59		9.52		5.74		25.85	
Land. (SOP)(t)	879		107		326		1,312	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.55	22.9	65.95	19.2	41.08	21.3	116.58	20.2
1	26.07	78.5	5.19	40.4	37.45	71.7	68.71	71.9
2								
3								
4								
5								
6								
7								
8+								
TOTAL	35.63		71.14		78.52		185.29	
Land. (SOP)(t)	2,265		1,476		3,558		7,299	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	11.12	21.5	75.37	18.2	42.07	21.2	128.56	19.4
1	53.26	62.3	194.44	18.5	161.31	32.6	409.01	29.8
2	22.13	68.7	51.82	49.8	28.31	60.3	102.26	56.8
3								
4								
5								
6								
7								
8+								
TOTAL	86.51		321.63		231.69		639.83	
Land. (SOP)(t)	5,079		7,549		7,852		20,480	

Table 3.3.3 Skagerrak 1994 Baltic Spring Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	5.94	87.5			7.85	87.5	13.79	87.5
4	1.18	107.5	0.08	71	1.55	107.5	2.81	106.5
5	0.34	141.1			0.46	141.1	0.80	141.1
6	0.14	160.5			0.28	167.4	0.42	165.1
7	0.03	179.3			0.03	179.3	0.06	179.3
8+	0.03	177.0			0.03	177.0	0.06	177.0
TOTAL	7.66		0.08		10.20		17.94	
Land. (SOP)(t)	728		6		976		1,709	
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	30.74	124.2	0.17	72.0	11.60	101.2	42.51	117.8
4	10.51	143.0			3.89	134.3	14.40	140.6
5	9.92	168.5			2.74	166.2	12.66	168.0
6	5.42	179.3			1.25	181.8	6.67	179.8
7	1.33	204.4			0.49	195.8	1.82	202.1
8+	0.69	197.0			0.27	190.4	0.96	195.1
TOTAL	58.61		0.17		20.24		79.02	
Land. (SOP)(t)	8,373		12		2,527		10,912	
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	83.94	143.3	0.25	69.6	26.87	130.9	111.06	140.1
3	53.82	140.3			23.18	127.5	77.00	136.4
4	47.21	156.2			27.18	146.8	74.39	152.8
5	22.69	159.2			17.13	163.6	39.82	161.1
6	14.89	200.7			5.32	178.4	20.21	194.8
7	2.72	207.8			2.66	195.3	5.38	201.6
8+	0.66	206.0			1.32	241.1	1.98	229.4
TOTAL	225.92		0.25		103.67		329.84	
Land. (SOP)(t)	34,256		17		15,054		49,327	
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	8.42	156.4			4.72	154.0	13.14	155.5
4	2.64	186.7			0.99	199.3	3.63	190.2
5	1.07	201.0			0.59	210.5	1.66	204.4
6	1.09	207.9			0.37	220.1	1.46	211.0
7	0.25	227.7			0.18	227.7	0.43	227.7
8+	0.32	276.5			0.22	276.5		
TOTAL	13.78		0.00		7.08		20.32	
Land. (SOP)(t)	2,395		0		1,233		3,479	
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	83.94	143.3	0.25	69.6	26.87	130.9	111.06	140.1
3	98.92	133.5	0.17	72.0	47.35	117.1	146.44	128.1
4	61.54	154.4	0.08	71.0	33.61	145.1	95.23	151.0
5	34.02	163.1			20.92	164.8	54.94	163.7
6	21.53	195.4			7.23	180.7	28.76	191.7
7	4.33	207.7			3.36	196.9	7.69	203.0
8+	1.70	215.0			1.84	236.9	3.54	226.4
TOTAL	305.98		0.50		141.18		447.66	
Land. (SOP)(t)	45,752		35		19,790		65,577	

Table 3.3.4 Kattegat 1994

Baltic Spring Spawning Herring

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	18.87	96.7	6.10	59.3	10.49	91.3	35.46	88.6
4	7.64	120.4	0.57	45.0	1.77	117.7	9.98	115.6
5	3.44	156.2			0.79	134.6	4.23	152.2
6	2.92	147.8			0.49	166.0	3.41	150.4
7	0.55	187.6			0.11	202.4	0.66	190.0
8+	0.31	223.9			0.11	196.9	0.42	216.6
TOTAL	33.74		6.67		13.75		54.16	
Land. (SOP)(t)		3,887		387		1,396		5,670
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	4.27	64.1	5.02	49.8	2.77	66.9	12.06	58.8
3	10.09	78.9	2.06	59.3	7.85	80.1	20.00	77.3
4	2.80	91.5	0.19	45	2.72	96.1	5.71	92.1
5	1.95	123.4			1.82	118.3	3.77	121.0
6	1.12	128.1			1.50	126.9	2.62	127.4
7	0.69	150.6			0.86	138.3	1.55	143.8
8+	0.47	147.7			0.72	147.7	1.19	147.7
TOTAL	21.40		7.27		18.23		46.90	
Land. (SOP)(t)		1,885		381		1,705		3,970
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	7.06	116.0			2.28	87.7	9.34	109.1
3	8.03	130.5			1.49	124.2	9.52	129.5
4	4.45	141.2			0.60	174.1	5.05	145.1
5	1.86	169.8			0.36	194.6	2.22	173.8
6	0.72	204.8			0.16	233.1	0.88	210.0
7	0.25	181.2			0.06	253.7	0.31	194.3
8+	0.24	132.0			0.04	239.2	0.28	146.3
TOTAL	22.61		0.00		4.99		27.60	
Land. (SOP)(t)		3,036		0		621		3,657
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	10.28	109.0			5.82	85.8	16.10	100.6
3	7.57	144.7			1.36	130.7	8.93	142.6
4	4.41	179.6			0.30	154.3	4.71	178.0
5	4.03	189.7			0.01	249.1	4.04	189.9
6	1.66	205.3			0.02	214.5	1.68	205.5
7	1.15	235.7			0.01	252.8	1.16	235.8
8+	0.57	284.1			0.01	301.0		
TOTAL	29.67		0.00		7.53		36.62	
Land. (SOP)(t)		4,547		0		735		5,117
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	21.61	102.4	5.02	49.8	10.87	81.4	37.50	89.3
3	44.55	106.9	8.16	59.3	21.20	92.0	73.91	97.4
4	19.31	134.5	0.76	45.0	5.38	115.1	25.45	127.7
5	11.28	164.7			2.98	132.5	14.26	158.0
6	6.42	165.6			2.17	144.4	8.59	160.3
7	2.65	198.2			1.03	152.1	3.68	185.4
8+	1.59	209.0			0.88	159.2	2.47	191.3
TOTAL	107.42		13.94		44.50		165.86	
Land. (SOP)(t)		13,354		768		4,457		18,579

Table 3.3.5

Total catch of Spring Spawners by Sub-divisions in 1994.

Numbers (millions) at age (rings) and SOP (t) by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	SOP
1	North Sea										0
	Skagerrak				13.79	2.81	0.80	0.42	0.06	0.06	1,709
	Kattegat				35.46	9.98	4.23	3.41	0.66	0.42	5,601
	Sub-div 22-24		28.27	20.73	43.67	49.99	32.81	28.20	9.72	8.59	22,640
	Total		28.27	20.73	92.92	62.78	37.84	32.03	10.44	9.07	29,950
2	North Sea				1.79	2.69	4.08	2.24	1.50	2.00	
	Skagerrak				42.51	14.40	12.66	6.67	1.82	0.96	10,912
	Kattegat			12.06	20.00	5.71	3.77	2.62	1.55	1.19	3,970
	Sub-div 22-24		37.56	40.79	63.12	53.37	44.53	40.26	23.77	15.34	27,013
	Total		37.56	52.85	127.42	76.17	65.04	51.79	28.64	19.49	41,895
3	North Sea			11.40	34.28	17.71	8.98	8.21	2.44	2.32	
	Skagerrak			111.06	77.00	74.39	39.82	20.21	5.38	1.98	49,327
	Kattegat			9.34	9.52	5.05	2.22	0.88	0.31	0.28	3,657
	Sub-div 22-24	100.17	9.19	18.15	22.57	10.46	4.57	1.08	0.84	0.13	5,950
	Total	100.17	9.19	149.95	143.37	107.61	55.59	30.38	8.97	4.71	58,934
4	North Sea				13.14	3.63	1.66	1.46	0.43		0
	Skagerrak				8.93	4.71	4.04	1.68	1.16		3,479
	Kattegat			16.10	31.65	22.24	8.93	4.48	0.78	0.41	5,117
	Sub-div 22-24	102.41	21.27	24.17	53.72	30.58	14.63	7.62	2.37	0.41	10,832
	Total	102.41	21.27	40.27	53.72	30.58	14.63	7.62	2.37	0.41	19,428
Total Year	North Sea			11.40	36.07	20.40	13.06	10.45	3.94	4.32	0
	Skagerrak			111.06	146.44	95.23	54.94	28.76	7.69	3.00	65,427
	Kattegat			37.50	73.91	25.45	14.26	8.59	3.68	1.89	18,345
	Sub-div 22-24	202.58	96.29	103.84	161.01	136.06	90.84	74.02	35.11	24.47	66,435
	Total	202.58	96.29	263.80	417.43	277.14	173.10	121.82	50.42	33.68	150,207

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8 +
1	North Sea									
	Skagerrak				87.5	106.5	141.1	165.1	179.3	177.0
	Kattegat				88.6	115.6	152.2	150.4	190.0	216.6
	Sub-div 22-24		19.7	44.3	79.1	106.2	137.6	157.2	175.9	202.2
	Total		19.7	44.3	84.0	107.7	139.3	156.6	176.8	202.7
2	North Sea				158.6	181.3	199.4	212.1	227.0	244.1
	Skagerrak				117.8	140.6	168.0	179.8	202.1	195.1
	Kattegat			58.8	77.3	92.1	121.0	127.4	143.8	147.7
	Sub-div 22-24		20.0	46.4	69.8	84.8	106.1	119.8	145.7	158.1
	Total		20.0	49.2	88.2	99.3	124.9	131.9	153.4	168.1
3	North Sea			126.5	136.5	164.4	173.0	219.2	226.8	245.6
	Skagerrak			140.1	136.4	152.8	161.1	194.8	201.6	229.4
	Kattegat			109.1	129.5	145.1	173.8	210.0	194.3	146.3
	Sub-div 22-24	12.9	48.7	65.7	70.9	77.4	88.5	85.5	116.3	116.3
	Total	12.9	48.7	128.1	125.7	147.0	157.6	197.9	200.2	229.3
4	North Sea				155.5	190.2	204.4	211.0	227.7	
	Skagerrak				142.6	178.0	189.9	205.5	235.8	
	Kattegat			100.6	89.6	102.6	117.1	120.3	187.2	189.8
	Sub-div 22-24	12.9	45.0	67.2	89.6	102.6	117.1	120.3	187.2	189.8
	Total	12.9	45.0	80.6	114.5	124.6	147.1	156.5	218.3	189.8
Total Year	North Sea			126.5	137.6	166.6	181.2	217.7	226.9	244.9
	Skagerrak			140.1	128.1	151.0	163.7	191.7	203.0	217.4
	Kattegat			89.3	97.3	127.7	158.0	160.3	185.3	162.8
	Sub-div 22-24	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9
	Total	12.9	28.2	98.5	103.5	122.5	140.4	156.4	169.7	186.3

Table 3.3.6 Total catch of North Sea Autumn Spawners in Division IIIa in 1994.

Numbers (millions) at age (rings) and SOP (t) by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	SOP
1	Skagerrak		111.67	59.89							4,995
	Kattegat		261.35	78.81							9,222
	Total		373.02	138.70							14,217
2	Skagerrak		354.71	85.68							13,388
	Kattegat		66.12	22.41							2,647
	Total		420.83	108.09							16,035
3	Skagerrak	192.96	169.96	16.59							19,324
	Kattegat	11.98	12.83	1.04							1,312
	Total	204.94	182.79	17.63							20,636
4	Skagerrak	220.71	194.30	40.80							27,527
	Kattegat	116.58	68.71								7,299
	Total	337.29	263.01	40.80							34,826
Total Year	Skagerrak	413.67	830.64	202.96							65,234
	Kattegat	128.56	409.01	102.26							20,480
	Total	542.23	1239.65	305.22							85,714

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8+
1	Skagerrak		15.4	54.7						
	Kattegat		18.5	55.5						
	Total		17.6	55.2						
2	Skagerrak		17.6	83.5						
	Kattegat		20.1	58.8						
	Total		18.0	78.4						
3	Skagerrak	11.3	89.0	121.9						
	Kattegat	11.7	82.5	109.2						
	Total	11.3	88.5	121.2						
4	Skagerrak	19.3	92.2	130.8						
	Kattegat	20.2	71.9							
	Total	19.6	86.9	130.8						
Total Year	Skagerrak	15.6	49.4	87.6						
	Kattegat	19.4	29.7	56.8						
	Total	16.5	42.9	77.3						

Table 3.3.7

Western Baltic Spring Spawning Herring

Landings of Herring from the North Sea, Div. IIIa and the Western Baltic area in 1994.

Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: HC in the North S C: Human consumption in Div. IIIa.

D: Mixed clupeoid fleet in Div IIIa

E: Industrial fishery (for reduction) in Div IIIa

F: Div. 22-24 Fisheries

1. Quarter												
W. rings	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1									28.27	19.7	28.27	19.7
2									20.73	44.3	20.73	44.3
3			24.81	94.5	6.10	59.3	18.34	89.7	43.67	79.1	92.92	84.0
4			8.82	118.6	0.65	48.2	3.32	112.9	49.99	106.2	62.78	107.7
5			3.78	154.9			1.25	137.0	32.81	137.6	37.84	139.3
6			3.08	148.4			0.77	166.5	28.20	157.2	32.03	156.6
7			0.58	187.2			0.14	197.3	9.72	175.9	10.44	178.8
8+			0.34	219.7			0.14	192.7	8.59	202.2	9.07	202.7
Total	0.00		41.39	111.5	6.75	58.23	23.96	99.0	221.98	102.0	294.08	102.1
SOP (t)		0		4,613		393		2,373		22,633		30,012
2. Quarter												
W. rings	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1									37.56	20.0	37.56	20.0
2			4.27	64.1	5.02	49.8	2.77	66.9	40.79	48.4	52.85	49.2
3	1.79	158.6	40.83	113.0	2.23	60.3	19.45	92.7	63.12	69.8	127.42	88.2
4	2.69	181.3	13.31	132.1	0.19	45.0	6.61	118.6	53.37	84.8	76.17	99.3
5	4.08	199.4	11.87	161.1			4.56	147.1	44.53	106.1	65.04	124.9
6	2.24	212.1	6.54	170.6			2.75	151.8	40.26	119.8	51.79	131.9
7	1.50	227.0	2.02	186.0			1.35	159.2	23.77	145.7	28.64	153.4
8+	2.00	244.1	1.16	177.0			0.99	159.4	15.34	158.1	19.49	168.1
Total	14.30	202.0	80.00	128.2	7.44	52.82	38.48	110.0	318.74	84.7	458.96	97.6
SOP (t)		2,889		10,256		393		4,233		27,012		44,783
3. Quarter												
W. rings	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									100.17	12.9	100.17	12.9
1									9.19	48.7	9.19	48.7
2	8.78	126.5	91.00	141.2			29.15	127.6	18.15	65.7	147.08	128.3
3	26.40	136.5	61.85	139.0			24.67	127.3	22.57	70.9	135.49	125.0
4	13.64	164.4	51.66	155.0			27.78	147.4	10.46	77.4	103.54	146.3
5	6.92	173.0	24.55	160.0			17.49	164.2	4.57	88.5	53.53	157.0
6	6.33	219.2	15.60	200.9			5.49	180.0	1.08	85.5	28.50	196.6
7	1.88	226.8	2.97	205.5			2.72	196.5	0.84	116.3	8.41	198.4
8+	1.51	245.6	0.91	186.2			1.35	241.1	0.13	116.3	3.90	225.9
Total	65.46	157.9	248.54	150.0	0.00		108.65	144.3	167.16	35.6	589.81	117.4
SOP (t)		10,339		37,292		0		15,674		5,952		69,255
4. Quarter												
W. rings	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									102.41	12.9	102.41	12.9
1									21.27	45.0	21.27	45.0
2			10.28	109.0			5.82	85.8	24.17	67.2	40.27	80.6
3			15.99	150.8			6.08	148.8	31.65	89.6	53.72	114.5
4			7.05	182.3			1.29	188.9	22.24	102.6	30.58	124.6
5			5.09	192.1			0.61	211.4	8.93	117.1	14.63	147.1
6			2.75	206.4			0.39	219.8	4.48	120.3	7.62	156.5
7			1.41	234.3			0.18	228.7	0.78	187.2	2.37	218.4
8+			0.89	281.4			0.23	277.3	0.41	189.8	1.53	256.2
Total	0.00		43.46	159.8	0.00		14.60	134.7	216.34	50.1	274.40	71.9
SOP (t)		0		6,943		0		1,967		10,829		19,739
Total Year												
W. rings	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									202.58	12.9	202.58	12.9
1									96.29	28.2	96.29	28.2
2	8.78	126.50	105.55	134.9	5.02	49.8	37.74	116.7	103.84	54.2	260.93	98.2
3	28.19	137.90	143.48	125.2	8.33	59.6	68.54	109.3	161.01	76.4	409.55	102.9
4	16.33	167.18	80.84	149.6			39.00	141.0	136.06	95.0	272.23	122.1
5	11.00	182.79	45.29	163.5			23.91	160.8	90.84	117.7	171.04	140.0
6	8.57	217.34	27.95	188.6			9.40	172.3	74.02	133.6	119.94	155.4
7	3.38	226.89	6.98	204.1			4.39	186.4	35.11	154.3	49.86	169.0
8+	3.51	244.75	3.30	212.1			2.71	211.8	24.47	173.9	33.99	187.9
Total	79.76	165.84	413.39	143.0	13.35	55.89	185.69	130.6	924.22	71.9	1616.41	101.3
SOP (t)		13,228		59,104		746		24,247		66,425		163,750

Table 3.3.8 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea in the year 1987 - 1994.

Year	Rings	0	1	2	3	4	5	6	7	8 +	Total
1987	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
	Mean W.			57.0	85.0	105.6	145.3	154.6	201.2	280.4	
	SOP			43,719	14,204	8,754	4,025	1,438	241	56	72,437
1988	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
1989	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
1990	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
1991	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
1992	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
1993	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	726
	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181
1994	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
	Mean W.			127.2	120.1	148.6	165.3	190.6	204.1	216.5	
	SOP		0	20,014	29,850	20,360	13,257	8,752	3,010	1,819	97,061

There may be minor corrections in data from 1987 and 1988.

Table 3.3.9 Herring Division IIIa, 1987 - 1994
Transfers of autumn spawners from Div. IIIa to the North Sea
Numbers (mill) and mean weight, SOP in (tonnes).

Year	Rings	0	1	2	3	4	5	6	7	8 +	Total
1987	Number	6238.00	3153.00	117.00							9508.00
	Mean W.	8.0	33.0	63.0							
	SOP	49,904	104,049	7,371							161,324
1988	Number	1830.00	5792.00	292.00							7914.00
	Mean W.	12.0	28.0	57.0							
	SOP	21,960	162,176	16,644							200,780
1989	Number	1028.2	1170.5	654.8							2853.50
	Mean W.	16.2	33.4	53.3							
	SOP	16,657	39,095	34,901							90,652
1990	Number	397.9	1424.3	283.7							2105.90
	Mean W.	31.0	34.1	55.4							
	SOP	12,335	48,569	15,717							76,621
1991	Number	712.3	822.7	330.2							1865.20
	Mean W.	25.3	40.7	77.8							
	SOP	18,021	33,484	25,690							77,195
1992	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
	Mean W.	12.3	50.6	94.8	164	171.7	184.7	197.5	202.7	219.8	
	SOP	29,612	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
1993	Number	2,957	2,351	350							5,658
	Mean W.	13	28	87							
	SOP	37,550	64,655	30,311							132,516
1994	Number	542.23	1239.65	305.19							2087.07
	Mean W.	16.5	42.9	77.3							
	SOP	8,947	53,181	23,591							85,719

There are minor corrections for the years previous to 1991.

Table 3.4.1

Herring in Division IIIa, IIIb and IIIc.

**Samples of commercial catches by quarter and Sub-Div.
for 1994 available to the Working Group.**

Skagerrak	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	1.8	11	498	7
		2	12.1	10	535	344
		3	24.7	14	1,606	1,018
		4	6.3	13	1,421	496
		Total	44.9	48	4,060	1,865
	Norway	1	0.0	0		
		2	3.5	0		
		3	12.6	0		
		4	1.6	0		
		Total	17.7	0	0	0
	Sweden	1	4.9	6	1,299	370
		2	8.5	1	186	85
		3	29.3	39	1,753	505
		4	23.7	42	3,570	1,264
		Total	66.4	88	6,808	2,224
Kattegat	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	0.2	9	282	158
		2	0.9	4	186	97
		3	6.0	11	1,116	918
		4	4.6	8	920	382
		Total	11.7	32	2,504	1,555
	Sweden	1	4.9	10	2,104	626
		2	3.6	17	3,530	1,112
		3	1.5	10	1,897	561
		4	5.5	31	5,281	635
		Total	15.5	28	12,812	2,934
Sub-Division 22-24	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	17.5	3	176	175
		2	11.4	4	282	279
		3	7.6	2	140	138
		4	7.6	6	1,056	1,050
		Total	44.1	15	1,654	1,642
	Germany	1	2.7	19	4,184	709
		2	8.2	20	6,556	963
		3	+	1	284	175
		4	0.6	8	2,110	385
		Total	11.5	48	13,134	2,232
	Poland	1	0.8	6	2,166	538
		2	5.3	14	3,802	1,088
		3	+	1	478	99
		4	0.1	1	507	85
		Total	6.2	22	6,953	1,810
	Sweden	1	1.5	5	1,014	264
		2	2.1	0	0	0
		3	1.3	5	1,057	269
		4	2.5	5	786	176
		Total	7.4	15	2,857	709

Table 3.5.1 Acoustic surveys on the spring-spawning herring in the North Sea, Division IIIa and in Sub-divisions 22-24 in 1992. (North Sea and Division IIIa in July and Sub-divisions 22-24 in October).

Numbers in millions				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			3412	3412
1			1658	1658
2		2458	657	3115
3	284	2214	282	2780
4	368	2075	156	2599
5	251	645	37	933
6	222	248	25	495
7	67	165	4	236
8+	37	11		48
Total	1229	7816	6231	15276
3 + group	1229	5358	504	7091
Biomass ('000 tonnes)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			53.2	53.2
1			61.3	61.3
2		210.7	39.6	250.2
3	53.8	239.1	20.6	313.5
4	68.7	260.0	14.4	343.1
5	52.2	90.2	4.6	147.0
6	48.3	40.7	3.3	92.3
7	16.4	32.7	0.7	49.8
8+	9.1	3.2		12.3
Total	248.5	876.5	197.7	1,322.7
Mean weight (g)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			15.6	15.6
1			37.0	37.0
2		85.7	60.2	80.3
3	189.4	108.0	73.0	112.8
4	186.7	125.3	92.1	132.0
5	208.0	139.8	125.6	157.6
6	217.6	164.1	132.0	186.5
7	244.8	198.2	168.1	210.9
8+	245.9	290.9		256.2
Mean weight	202.2	112.2	31.7	86.6

Table 3.5.2 Acoustic surveys on the spring-spawning herring in the North Sea, Division IIIa and in Sub-divisions 22-24 in 1993. (North Sea and Division IIIa in July and Sub-divisions 22-24 in October).

Numbers in millions				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			1414	1414
1			466	466
2	320	1488	393	2201
3	315	621	518	1454
4	192	380	402	974
5	150	246	145	541
6	50	91	64	205
7	44	27	31	102
8+	12	4	16	32
Total	1083	2857	3449	7389
3+ group	763	1369	1176	3308
Biomass ('000 tonnes)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			21	21
1			16	16
2	29	75	18	122
3	35	54	34	124
4	27	42	28	98
5	24	39	16	79
6	9	15	9	34
7	11	7	4	22
8+	3	1	3	7
Total	139	234	150	523
Mean weight (g)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			14.9	14.9
1			35.2	35.2
2	90.3	50.6	45.6	55.5
3	111.6	87.6	65.8	85.0
4	142.4	111.3	69.7	100.3
5	162.0	158.7	111.2	146.9
6	187.8	164.2	146.2	164.3
7	247.0	276.8	125.4	217.9
8+	268.3	216.8	171.3	213.4
Mean weight	125.7	82.0	43.4	70.8

Table 3.5.3 Acoustic surveys on the spring-spawning herring in the North Sea, Division IIIa and in Sub-divisions 22-24 in 1994. (North Sea and Division IIIa in July and Sub-divisions 22-24 in October).

Numbers in millions				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			6,749.0	6,749.0
1	3.2		456.6	459.8
2	141.6	1,319.7	831.0	2,292.2
3	198.9	3,134.7	525.0	3,858.6
4	150.4	1,613.0	449.0	2,212.4
5	60.4	771.2	195.0	1,026.6
6	76.5	418.3	62.6	557.4
7	31.9	143.8	24.6	200.4
8 +	19.1	94.6	2.0	115.7
Total	682.02	7495.24	9294.8	17472.06
3 + group	537.29	6175.58	1258.2	7971.07
Biomass ('000 tonnes)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			77.0	77.0
1	0.3		16.0	16.2
2	14.5	110.8	38.1	163.4
3	25.1	339.8	38.8	403.7
4	24.4	230.3	43.2	297.9
5	11.5	124.2	24.9	160.7
6	18.5	82.7	12.9	114.1
7	8.2	29.9	5.0	43.1
8 +	5.1	18.8	0.0	24.0
Total	107.5	936.5	255.9	1,300.0
Mean weight (g)				
	North Sea	Div. IIIa	Sub-Div. 22-24	Total
W-rings				
0			11.4	11.4
1	80.0		34.9	35.3
2	102.5	84.0	45.8	71.3
3	126.2	108.4	73.8	104.6
4	161.9	142.8	96.3	134.6
5	190.6	161.1	127.7	156.5
6	241.8	197.7	206.3	204.7
7	255.5	207.8	204.5	215.0
8 +	269.1	198.8		207.0
Mean weight	157.6	125.0	27.5	74.4

Table 3.6.1 Recruitment indices for 1-, 2- and 3+ringed herring from the IBTS in Division IIIa. Indices are given for autumn and spring-spawners based on modal length analysis and vertebrae counts. The indices are weighted by area of four depth strata.

INDEX							
Year	Total		Spring spawners			Autumn spawners	
	1-ringers	2-ringers	1-ringers	2-ringers	3+ ringers	1-ringers	2-ringers
1980	2,311	387	1,607	307	162	704	80
1981	3,246	1,393	996	1,318	349	2,250	75
1982	2,560	549	1,408	445	196	1,152	104
1983	5,419	1,063	1,522	946	240	3,897	117
1984	6,035	1,947	2,793	1,419	445	3,242	528
1985	7,994	2,473	-*	1,867	2,037	-*	606
1986	21,489	2,738	-*	1,562	1,897	-*	1,175
1987	11,733	3,671	-*	2,921	1,199	-*	949
1988	67,753	10,095	-*	7,834	7,084	-*	2,161
1989	17,451	4,976	-*	0	3,989	-*	4,976
1990	3,544	3,876	0	3,192	508	3,544	684
1991	3,588	3,749	-*	480	3,392	-*	3,269
1992	5,057	1,934	0	771	1,268	5,057	1,163
1993	26,738	3,165	0	203	264	26,738	2,962
1994	8,777	2,333	0	0	1,148	8,777	2,333
1995	7,114	535	0	0	344	7,114	535

*Separation not valid.

Table3.6.2. German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey
Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total numbers	Mean catch in kg. Herring
		0	1	2	3 +		
Nov.	1978	592.72	51.04	32.06	11.81	687.63	13.58
Nov.	1979	8,665.90	240.47	103.36	10.33	9,020.06	89.61
Nov.	1981	332.63	96.79	60.05	21.30	510.77	16.36
Dec.	1982	695.71	108.21	70.63	34.72	909.27	24.57
Dec.	1983	1,995.97	387.11	63.71	46.11	2,492.90	46.68
Nov.	1984	1,581.66	377.15	88.03	24.26	2,071.10	39.79
Nov.	1985	3,085.64	340.92	169.95	74.76	3,671.27	45.99
Dec.	1986	2,984.47	368.35	46.41	69.30	3,468.53	44.42
Nov.	1989	2,881.81	319.38	48.99	55.12	3,305.30	47.76
Nov.	1990	103.92	14.79	21.69	32.90	173.30	7.09
Nov.	1991	117.38	134.20	103.14	144.63	499.35	27.16
Nov.	1992	233.85	88.05	57.15	113.58	492.63	19.86
Nov.	1993	1,744.19	37.10	63.87	544.65	2,389.81	66.46
Nov.	1994	1,102.30	12.97	73.67	605.24	1,794.17	83.15

Table3.6.3. German Bottom Trawl Survey in Sub-Div. 22.
Young Fish survey
Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total Numbers	Mean catch in kg. Herring
		0	1	2	3 +		
Nov.	1979	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
Nov.	1981	1,033.40	118.85	28.35	9.10	1,189.70	17.69
Dec.	1982	354.00	239.45	44.50	26.20	664.15	19.97
Dec.	1983	7,917.00	834.70	80.10	29.50	8,861.30	117.51
Nov.	1984	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
Nov.	1985	3,506.20	958.80	219.80	25.25	4,710.05	83.38
Nov.	1986	6,863.75	175.35	16.55	5.60	7,061.25	54.18
Nov.	1989	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
Nov.	1992	572.68	87.68	19.16	17.26	696.78	13.13
Nov.	1993	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
Nov.	1994	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65

Table 3.6.4 German Bottom Trawl Survey in Sub-Div. 22 and 24.
Young Fish survey
Mean catch at age in numbers per haul.

Sum weighted by area of sub-division :

Area of 24 is	3794 sq.nm
Area of 22 is	2640 sq.nm
Total	6434 sq.nm

Month	Year	Winter rings				Total Numbers	Mean catch in kg. Herring
		0	1	2	3 +		
Nov.	1979	6571.6	699.4	117.2	9.2	7397.4	88.5
Nov.	1981	620.2	105.8	47.0	16.3	789.3	16.9
Dec.	1982	555.5	162.1	59.9	31.2	808.7	22.7
Dec.	1983	4425.5	570.8	70.4	39.3	5106.0	75.7
Nov.	1984	3639.3	973.4	113.7	30.9	4757.3	84.0
Nov.	1985	3258.2	594.4	190.4	54.4	4097.5	61.3
Nov.	1986	4576.2	289.2	34.2	43.2	4942.7	48.4
Nov.	1989	6043.7	781.0	77.2	63.9	6965.8	100.6
Nov.	1992	372.9	87.9	41.6	74.1	576.4	17.1
Nov.	1993	4483.3	696.5	568.5	689.7	6437.9	163.0
Nov.	1994	1535.5	137.9	695.2	490.8	2859.4	104.7

Table 3.8.1 *WESTERN BALTIC HERRING. Input to ICA. CATCH NUMBERS AT AGE (Millions)*

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	91.	256.	89.	60.	204.	296.	2033.	1032.	1709.	555.	1173.	1053.	771.	611.	130.	161.	87.	36.	45.	203.
1	466.	438.	1310.	703.	239.	636.	651.	1101.	1777.	2101.	1035.	1020.	1440.	861.	1232.	427.	831.	278.	212.	96.
2	301.	585.	488.	931.	1074.	494.	1005.	572.	850.	1207.	849.	468.	988.	2443.	854.	1168.	532.	539.	366.	261.
3	242.	229.	291.	586.	440.	908.	467.	779.	485.	521.	844.	611.	388.	928.	936.	475.	632.	360.	442.	410.
4	257.	110.	140.	70.	105.	143.	277.	150.	348.	235.	353.	390.	394.	205.	359.	456.	290.	318.	268.	273.
5	138.	55.	50.	19.	13.	25.	58.	84.	39.	162.	108.	123.	125.	152.	88.	168.	176.	174.	214.	171.
6	51.	27.	21.	8.	4.	7.	18.	18.	14.	24.	35.	28.	37.	41.	45.	37.	48.	130.	105.	120.
7	19.	11.	7.	4.	3.	2.	4.	4.	2.	8.	7.	10.	10.	11.	16.	31.	14.	48.	66.	50.
8	2.	4.	4.	5.	1.	2.	4.	3.	3.	2.	6.	3.	4.	6.	6.	7.	5.	22.	22.	33.

Table 3.8.2 *WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.*
INDEX 1: IYFS IIIa Age groups 2 and 3+ (Catch: Number)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	.307E+03	.132E+04	.445E+03	.946E+03	.142E+04	.187E+04	.156E+04	.292E+04	.783E+04	-.100E+01	.319E+04	.480E+03	.771E+03	.203E+03	-.100E+01	-.100E+01
3	.162E+03	.349E+03	.196E+03	.240E+03	.445E+03	.204E+04	.190E+04	.120E+04	.708E+04	.399E+04	.508E+03	.339E+04	.127E+04	.264E+03	.115E+04	.344E+03

Table 3.8.3 *WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.*
INDEX 2: German Bottom Trawl Survey in sub div 24 (Catch: Number)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.593E+03	.867E+04	-.110E+02	.333E+03	.696E+03	.200E+04	.158E+04	.309E+04	.298E+04	N.A.	N.A.	.288E+04	.104E+03	.117E+03	.234E+03	.174E+04	.110E+04
1	.510E+02	.240E+03	-.110E+02	.970E+02	.108E+03	.387E+03	.377E+03	.341E+03	.368E+03	N.A.	N.A.	.319E+03	.150E+02	.134E+03	.880E+02	.370E+02	.130E+02
2	.320E+02	.103E+03	-.110E+02	.600E+02	.710E+02	.640E+02	.880E+02	.170E+03	.460E+02	N.A.	N.A.	.490E+02	.220E+02	.103E+03	.570E+02	.640E+02	.740E+02
3	.120E+02	.100E+02	-.110E+02	.210E+02	.350E+02	.460E+02	.240E+02	.750E+02	.690E+02	N.A.	N.A.	.550E+02	.330E+02	.145E+03	.114E+03	.545E+03	.605E+03

Table 3.8.4 *WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.*
INDEX 3: German Bottom Trawl Survey in sub div 22 (Catch: Number)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.356E+04	N.A.	.103E+04	.354E+03	.792E+04	.660E+04	.351E+04	.686E+04	N.A.	N.A.	.106E+05	N.A.	N.A.	.573E+03	.842E+04	.216E+04
1	.136E+04	N.A.	.119E+03	.239E+03	.835E+03	.183E+04	.959E+03	.175E+03	N.A.	N.A.	.144E+04	N.A.	N.A.	.880E+02	.164E+04	.317E+03
2	.137E+03	N.A.	.280E+02	.440E+02	.800E+02	.150E+03	.220E+03	.170E+02	N.A.	N.A.	.118E+03	N.A.	N.A.	.190E+02	.129E+04	.159E+04
3	.800E+01	N.A.	.900E+01	.260E+02	.300E+02	.400E+02	.250E+02	.600E+01	N.A.	N.A.	.760E+02	N.A.	N.A.	.170E+02	.898E+03	.326E+03

Table 3.8.5 **WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.**
INDEX 4: Acoustic Survey in Div IIIa+IVaE, Ages 2-8 (Catch: Number)

	1989	1990	1991	1992	1993	1994
2	.111E+04	.104E+04	.186E+04	.246E+04	.181E+04	.146E+04
3	.714E+03	.343E+03	.193E+04	.250E+04	.936E+03	.333E+04
4	.317E+03	.109E+03	.866E+03	.244E+04	.572E+03	.176E+04
5	.807E+02	.453E+02	.350E+03	.896E+03	.396E+03	.832E+03
6	.514E+02	.708E+01	.880E+02	.470E+03	.141E+03	.495E+03
7	.163E+02	.731E+01	.720E+02	.232E+03	.710E+02	.176E+03
8	.420E+01	.194E+01	.100E+02	.480E+02	.160E+02	.114E+03

Table 3.8.6 **WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.**
INDEX 5: Acoustic Survey in Sub div 22-24, Ages 0-8 (Catch: Number)

	1989	1990	1991	1992	1993	1994
0	.383E+04	.212E+05	.736E+04	.341E+04	.141E+04	.675E+04
1	.214E+04	.179E+04	.322E+04	.166E+04	.466E+03	.457E+03
2	.213E+03	.892E+03	.176E+04	.657E+03	.393E+03	.831E+03
3	.161E+03	.146E+03	.143E+04	.282E+03	.518E+03	.525E+03
4	.102E+03	.790E+02	.461E+03	.156E+03	.402E+03	.449E+03
5	.230E+02	.190E+02	.174E+03	.370E+02	.145E+03	.195E+03
6	.400E+01	.800E+01	.440E+02	.250E+02	.640E+02	.630E+02
7	.300E+01	.400E+01	.240E+02	.400E+01	.310E+02	.250E+02
8	.100E+01	.200E+01	.210E+02	.100E+01	.160E+02	.200E+01

Table 3.8.7 **WESTERN BALTIC HERRING. Output from ICA. FISHING MORTALITY**

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.0333	.0579	.0176	.0245	.0395	.0813	.3481	.1382	.2284	.1386	.1673	.1005	.1264	.0772	.0312	.0251	.0176	.0154	.0150	.0128
1	.2999	.2215	.4619	.1877	.1282	.1663	.2572	.3224	.3717	.4838	.4112	.2148	.1939	.2029	.1780	.1432	.1003	.0880	.0857	.0729
2	.4449	.7600	.4100	.7083	.4835	.4209	.4272	.3772	.4432	.4667	.3677	.3302	.3326	.5807	.3241	.2607	.1827	.1602	.1560	.1326
3	.7063	.7302	1.1621	1.3192	.8990	1.0123	.9148	.6978	.6395	.5392	.7051	.4941	.5027	.5992	.4091	.3291	.2305	.2022	.1968	.1674
4	1.2025	.8408	1.5740	1.0402	.9248	.8646	1.0566	.8851	.7982	.7530	.8871	.8592	.6964	.5468	.4789	.3852	.2699	.2367	.2304	.1960
5	1.3577	.9443	1.2972	1.0203	.5419	.5884	1.1327	1.1831	.6051	1.1728	.9893	.9348	.7631	.6438	.4834	.3888	.2724	.2389	.2326	.1978
6	1.1908	1.1772	1.3040	.7427	.6146	.6392	1.1967	1.5715	.6255	.9709	.8948	.7696	.8419	.6157	.4569	.3675	.2575	.2258	.2198	.1870
7	1.0145	.9306	1.2391	.9875	.7029	.7286	.9712	.9910	.7428	.9258	.8800	.7060	.6561	.6559	.4789	.3852	.2699	.2367	.2304	.1960
8	1.0145	.9306	1.2391	.9875	.7029	.7286	.9712	.9910	.7428	.9258	.8800	.7060	.6561	.6559	.4789	.3852	.2699	.2367	.2304	.1960

Table 3.8.8 *WESTERN BALTIC HERRING. Output from ICA. NUMBERS AT AGE (Millions)*

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	3060.	5019.	5617.	2738.	5804.	4177.	7585.	8802.	9201.	4720.	8376.	12135.	7147.	9063.	5822.	7764.	5359.	3352.	2333.	14641.	4359.
1	1974.	2424.	3878.	4518.	2188.	4568.	3153.	4385.	6277.	5995.	3364.	5801.	8986.	5156.	6869.	4620.	6199.	4311.	2702.	1882.	11835.
2	918.	1197.	1590.	2001.	3066.	1576.	3167.	1996.	2600.	3544.	3026.	1826.	3831.	6060.	3447.	4707.	3278.	4591.	3232.	2031.	1432.
3	521.	482.	459.	864.	807.	1548.	847.	1691.	1121.	1367.	1819.	1715.	1074.	2249.	2776.	2041.	2969.	2236.	3202.	2264.	1456.
4	398.	211.	190.	117.	189.	269.	461.	278.	689.	484.	653.	736.	857.	532.	1011.	1510.	1202.	1930.	1495.	2153.	1568.
5	201.	98.	74.	32.	34.	61.	93.	131.	94.	254.	187.	220.	255.	350.	252.	513.	841.	751.	1247.	972.	1449.
6	79.	42.	31.	17.	10.	16.	28.	24.	33.	42.	64.	57.	71.	97.	150.	127.	285.	524.	485.	809.	653.
7	32.	20.	11.	7.	6.	4.	7.	7.	4.	14.	13.	22.	22.	25.	43.	78.	72.	180.	342.	318.	550.
8	2.	10.	10.	5.	4.	4.	3.	3.	3.	3.	6.	6.	11.	14.	17.	30.	60.	83.	170.	333.	439.

Table 3.8.9 *WESTERN BALTIC HERRING. Output from ICA. STOCK SUMMARY*

Year	Recruits x10 ⁶	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Ref. F Fbar 2-6
1975	3060.	235169.	122278.	106000.	.8669	.9804
1976	5019.	209301.	86667.	86000.	.9923	.8905
1977	5617.	248307.	80239.	89000.	1.1092	1.1494
1978	2738.	295327.	91440.	124000.	1.3561	.9661
1979	5804.	331730.	109174.	123500.	1.1312	.6928
1980	4177.	414729.	153210.	143000.	.9334	.7051
1981	7585.	445209.	152367.	158000.	1.0370	.9456
1982	8802.	485676.	185726.	151000.	.8130	.9429
1983	9201.	557904.	189790.	224000.	1.1802	.6223
1984	4720.	656778.	231027.	261000.	1.1297	.7805
1985	8376.	567912.	273374.	247000.	.9035	.7688
1986	12135.	503204.	242934.	186000.	.7656	.6776
1987	7147.	534709.	205753.	174700.	.8491	.6273
1988	9063.	640204.	257508.	251000.	.9747	.5973
1989	5822.	583600.	265393.	185700.	.6997	.4305
1990	7764.	644536.	324298.	203900.	.6287	.3463
1991	5359.	803120.	441758.	191500.	.4335	.2426
1992	3352.	880440.	547974.	168000.	.3066	.2128
1993	2333.	931933.	648484.	166631.	.2570	.2071
1994	14641.	922953.	702566.	163435.	.2326	.1762

Table 3.8.10 WESTERN BALTIC HERRING. Output from ICA. PARAMETER ESTIMATES +/- SD

		Parameter estimate	Parameter-SD	Parameter+SD
Separable Model: Reference F by year				
1	1989	.4789	.4033	.5687
2	1990	.3852	.3207	.4628
3	1991	.2699	.2224	.3274
4	1992	.2367	.1938	.2891
5	1993	.2304	.1872	.2837
6	1994	.1960	.1569	.2447
Separable Model: Selection (S) by age				
7	0	.0652	.0539	.0788
8	1	.3717	.3129	.4417
9	2	.6768	.5765	.7947
10	3	.8542	.7346	.9934
	4	1.0000	Fixed : Reference age	
11	5	1.0093	.8873	1.1481
12	6	.9540	.8407	1.0826
	7	1.0000	Fixed : last true age	
Separable Model: Populations in year 1994				
13	0	14641115.	10629481.	20166765.
14	1	1881839.	1495656.	2367736.
15	2	2030959.	1680116.	2455065.
16	3	2264314.	1891843.	2710117.
17	4	2153357.	1798141.	2578745.
18	5	972400.	802584.	1178147.
19	6	809296.	655747.	998800.
20	7	318404.	251741.	402718.
Separable Model: Populations at age 7				
21	1989	43082.7936	32918.5024	56385.5268
22	1990	77942.4305	61385.8812	98964.4908
23	1991	72180.6031	57000.4788	91403.4332
24	1992	180169.4522	141815.0977	228896.8665
25	1993	342491.1459	271162.1482	432583.1825

Table 3.8.11. WESTERN BALTIC HERRING. Output from ICA. Age-structured index catchabilities

Age-Structured Index 1 Linear model fitted. Slopes at age:				
26	2 Q	.37622E-03	.29526E-03	.47938E-03
27	3 Q	.26310E-03	.19684E-03	.35168E-03
Age-Structured Index 2 Linear model fitted. Slopes at age:				
28	0 Q	.20318E-03	.14082E-03	.29314E-03
29	1 Q	.40932E-04	.30271E-04	.55349E-04
30	2 Q	.36650E-04	.30697E-04	.43758E-04
31	3 Q	.42424E-04	.35610E-04	.50542E-04
Age-Structured Index 3 Linear model fitted. Slopes at age:				
32	0 Q	.60662E-03	.40771E-03	.90258E-03
33	1 Q	.19830E-03	.13713E-03	.28676E-03
34	2 Q	.65009E-04	.40980E-04	.10313E-03
35	3 Q	.26021E-04	.18754E-04	.36106E-04
Age-Structured Index 4 Linear model fitted. Slopes at age:				
36	2 Q	.58278E-03	.47832E-03	.71006E-03
37	3 Q	.64889E-03	.45457E-03	.92630E-03
38	4 Q	.59012E-03	.38904E-03	.89512E-03
39	5 Q	.54086E-03	.36721E-03	.79664E-03
40	6 Q	.42383E-03	.27806E-03	.64602E-03
41	7 Q	.56915E-03	.36373E-03	.89060E-03
42	8 Q	.26403E-03	.17664E-03	.39466E-03
Age-Structured Index 5 Linear model fitted. Slopes at age:				
43	0 Q	.11229E-02	.83162E-03	.15162E-02
44	1 Q	.40612E-03	.33091E-03	.49842E-03
45	2 Q	.26016E-03	.18652E-03	.36288E-03
46	3 Q	.20950E-03	.15217E-03	.28842E-03
47	4 Q	.21573E-03	.15565E-03	.29902E-03
48	5 Q	.14407E-03	.10459E-03	.19847E-03
49	6 Q	.10453E-03	.76470E-04	.14288E-03
50	7 Q	.11282E-03	.73726E-04	.17263E-03
51	8 Q	.91146E-04	.44880E-04	.18511E-03

Table 3.8.12 WESTERN BALTIC HERRING. Output from ICA.
RESIDUALS ABOUT THE MODEL FIT *Separable Model Residuals*
(log(Observed Catch)-log(Expected Catch)) and weights (W) used in the analysis.

Age	1989	1990	1991	1992	1993	1994	
0	-.22408E+00	-.84020E-01	.27675E-01	-.25388E+00	.35231E+00	.18434E+00	.10000E+01
1	.19036E+00	-.27080E+00	.43588E+00	-.17149E+00	.52188E-01	-.22002E+00	.10000E+01
2	-.17518E-01	.17225E+00	.66779E-01	-.13605E+00	-.14733E+00	.13073E+00	.10000E+01
3	.95983E-01	-.93278E-01	.12767E+00	-.32964E-01	-.16382E+00	.25541E+00	.10000E+01
4	.19437E-01	.35376E-01	.11214E+00	-.15274E+00	-.42130E-01	-.24384E+00	.10000E+01
5	-.57031E-02	.10850E+00	-.34249E-01	.17887E+00	-.95120E-01	.74925E-01	.10000E+01
6	-.10350E+00	.35643E-01	-.19701E+00	.30182E+00	.19282E+00	-.45101E-01	.10000E+01
7	.53435E-01	.32317E+00	-.11894E+00	.33481E+00	.29852E-01	-.32892E-01	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

Table 3.8.13 WESTERN BALTIC HERRING. Output from ICA.
Aged Index Residuals: $\log(\text{Observed Index}) - \log(\text{Expected Index})$

Aged Index 1												
Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	-.59369E+00	.16585E+00	-.46354E+00	.32944E-01	.13139E+00	.55352E+00	.87635E+00	.76147E+00	.13151E+01	-.10000E+01	.63697E+00	-.90408E+00
3	-.10068E+01	.41221E-01	-.95322E+00	-.66408E+00	-.15639E+00	.11388E+01	.10480E+01	.77265E+00	.21916E+01	.13374E+01	-.74260E+00	.91120E+00
Aged Index 2												
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	-.76928E+00	-.17533E+01	-.10000E+01	-.10000E+01								
3	-.12497E+00	-.18913E+01	-.41124E+00	-.15024E+01								
Aged Index 3												
Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.27597E+00	.22208E+01	-.10000E+01	-.10142E+01	-.62419E+00	.47028E+00	.82049E+00	.94235E+00	.47476E+00	-.10000E+01	-.10000E+01	.11089E+01
1	-.92184E+00	.12960E+01	-.10000E+01	.14646E+00	-.14222E-01	.94991E+00	.10755E+01	.14843E+01	.83018E+00	-.10000E+01	-.10000E+01	.48353E+00
2	.29223E-01	.55882E+00	-.10000E+01	-.67152E-01	.51551E+00	.20956E+00	.24077E+00	.96372E+00	.12621E+00	-.10000E+01	-.10000E+01	-.45167E+00
3	.73550E-01	-.46801E+00	-.10000E+01	.45652E-01	-.49652E-01	.25867E+00	-.53471E+00	.47687E+00	.24709E+00	-.10000E+01	-.10000E+01	-.58966E+00
Aged Index 4												
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	-.25065E+01	-.20251E+01	-.86478E+00	.15058E+01	-.79197E+00							
1	-.22101E+01	-.35468E+00	-.42365E+00	-.82523E+00	-.15214E+01							
2	-.16239E+01	.20762E+00	-.74204E+00	-.27939E+00	.30849E+00							
3	-.11821E+01	-.39490E-01	-.35372E+00	.10071E+01	.10976E+01							
Aged Index 5												
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.23794E+00	-.10000E+01	-.97591E+00	-.23941E+01	.75433E+00	.11544E+01	-.23870E-01	.21396E+00	-.10000E+01	-.10000E+01	.13164E+01	-.10000E+01
1	.14520E+01	-.10000E+01	-.12270E+01	-.79776E+00	.14104E+00	.10775E+01	.94040E+00	-.14910E+01	-.10000E+01	-.10000E+01	.41564E+00	-.10000E+01
2	.27096E+00	-.10000E+01	-.14024E+01	-.53609E+00	-.14041E+00	.20097E+00	.64845E+00	-.14423E+01	-.10000E+01	-.10000E+01	-.14591E+00	-.10000E+01
3	-.20237E+00	-.10000E+01	-.31286E+00	.14188E+00	.32001E+00	.46490E+00	-.13297E+00	-.17065E+01	-.10000E+01	-.10000E+01	.22252E+00	-.10000E+01
Aged Index 6												
Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-.10000E+01	-.10630E+01	.19864E+01	-.12137E+01								
1	-.10000E+01	-.20015E+01	.13909E+01	.94706E-01								
2	-.10000E+01	-.24138E+01	.21541E+01	.28022E+01								
3	-.10000E+01	-.17679E+01	.19953E+01	.96802E+00								
Aged Index 7												
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-.27001E+00	-.68472E+00	.21452E+00	.14035E+00	.18141E+00	.41846E+00						
3	-.54430E+00	-.10192E+01	.26931E+00	.79472E+00	-.54949E+00	.10490E+01						
4	-.20778E+00	-.17315E+01	.49305E+00	.10359E+01	-.16460E+00	.57491E+00						
5	-.97617E-01	-.14454E+01	.33290E-01	.10648E+01	-.26237E+00	.70728E+00						
6	.19573E+00	-.16763E+01	-.29702E-01	.10152E+01	-.11358E+00	.60866E+00						
7	.15939E-01	-.14374E+01	.85475E+00	.10894E+01	-.74096E+00	.21825E+00						
8	.38604E+00	-.10488E+01	-.17062E+00	.10596E+01	-.76197E+00	.50668E+00						
Aged Index 8												
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-.35111E+00	.10666E+01	.37526E+00	.74126E-01	-.44475E+00	-.72014E+00						
1	.35957E-01	.22459E+00	.48759E+00	.17590E+00	-.62810E+00	-.29593E+00						
2	-.10181E+01	.51788E-01	.10329E+01	-.30952E+00	-.47596E+00	.71893E+00						
3	-.79707E+00	-.65112E+00	.11797E+01	-.18569E+00	.58852E-01	.39533E+00						
4	-.21726E+00	-.94835E+00	.95107E+00	-.63250E+00	.56431E+00	.28273E+00						
5	.89561E-01	-.88726E+00	.73991E+00	-.72259E+00	.13148E+00	.64890E+00						
6	-.84275E+00	-.54924E-01	.75711E+00	-.44422E+00	.56992E+00	.14862E-01						
7	.60589E-01	-.31952E+00	.14568E+01	-.12762E+01	.12407E+00	-.45665E-01						
8	.13337E+00	.14766E+00	.17172E+01	-.10000E+01	.37696E+00	-.24035E+01						

Table 3.8.14 WESTERN BALTIC HERRING. Output from ICA.

PARAMETERS OF THE DISTRIBUTION OF \ln CATCHES AT AGE

Separable model fitted from 1989 to 1994
 Variance : .0623
 Skewness test statistic : 1.9863
 Kurtosis test statistic : -.4834
 Partial chi-square : .1235
 Probability of chi-square : 1.0000
 Degrees of freedom : 23
 Linear catchability relationship assumed.

Table 3.8.15 WESTERN BALTIC HERRING. Output from ICA.

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR \ln AGED INDEX 1

Age	:	2	3
Variance	:	.7405	1.2916
Skewness test stat.	:	-.6150	.3021
Kurtosis test stat.	:	-.4126	-.6928
Partial chi-square	:	1.2488	2.8340
Prob. of chi-square	:	1.0000	.9997
Number of data	:	13	16
Degrees of freedom	:	12	15
Weight in analysis	:	.0842	.0483

DISTRIBUTION STATISTICS FOR \ln AGED INDEX 2

Linear catchability relationship assumed.					
Age	:	0	1	2	3
Variance	:	1.8223	1.2247	.4029	.3816
Skewness test stat.	:	-.4525	-.6788	-1.6855	.1698
Kurtosis test stat.	:	-.5617	-.5701	.9639	-.2237
Partial chi-square	:	3.4684	3.4601	1.1731	1.0707
Prob. of chi-square	:	.9956	.9957	1.0000	1.0000
Number of data	:	14	14	14	14
Degrees of freedom	:	13	13	13	13
Weight in analysis	:	.0342	.0509	.1547	.1633

DISTRIBUTION STATISTICS FOR \ln AGED INDEX 3

Linear catchability relationship assumed.					
Age	:	0	1	2	3
Variance	:	1.6970	1.4661	2.3228	1.1501
Skewness test stat.	:	-.3553	-.4622	.4941	-.1771
Kurtosis test stat.	:	-.5343	-.8527	-.2975	-.0576
Partial chi-square	:	2.1656	2.3515	4.8220	2.7158
Prob. of chi-square	:	.9949	.9929	.9028	.9873
Number of data	:	11	11	11	11
Degrees of freedom	:	10	10	10	10
Weight in analysis	:	.0367	.0425	.0268	.0542

DISTRIBUTION STATISTICS FOR \ln AGED INDEX 4

Linear catchability relationship assumed.								
Age	:	2	3	4	5	6	7	8
Variance	:	.1631	.6883	.9430	.7605	.8526	.9161	.6476
Skewness test stat.	:	-.8277	.1112	-.9051	-.4880	-.9552	-.3620	-.0940
Kurtosis test stat.	:	-.3299	-.7723	-.1086	-.2749	.0016	-.5684	-.6713
Partial chi-square	:	.1103	.4896	.7232	.6916	1.0531	1.2082	1.4209
Prob. of chi-square	:	.9998	.9925	.9817	.9834	.9582	.9441	.9220
Number of data	:	6	6	6	6	6	6	6
Degrees of freedom	:	5	5	5	5	5	5	5
Weight in analysis	:	.3822	.0906	.0661	.0820	.0731	.0680	.0963

DISTRIBUTION STATISTICS FOR \ln AGED INDEX 5

Linear catchability relationship assumed.										
Age	:	0	1	2	3	4	5	6	7	8
Variance	:	.4247	.1605	.5890	.5290	.5299	.4606	.3618	.7748	2.2267
Skewness test stat.	:	.6031	-.4803	.1361	.5209	-.0305	-.2764	-.0677	.3155	-.6728
Kurtosis test stat.	:	-.4108	-.4596	-.6215	-.4085	-.6893	-.7254	-.6038	-.0675	-.1587
Partial chi-square	:	.2395	.1146	.4638	.4450	.4962	.5471	.6538	1.9133	4.3195
Prob. of chi-square	:	.9986	.9998	.9934	.9940	.9923	.9903	.9854	.8610	.3645
Number of data	:	6	6	6	6	6	6	6	6	5
Degrees of freedom	:	5	5	5	5	5	5	5	5	4
Weight in analysis	:	.1468	.3884	.1058	.1178	.1176	.1353	.1723	.0805	.0280

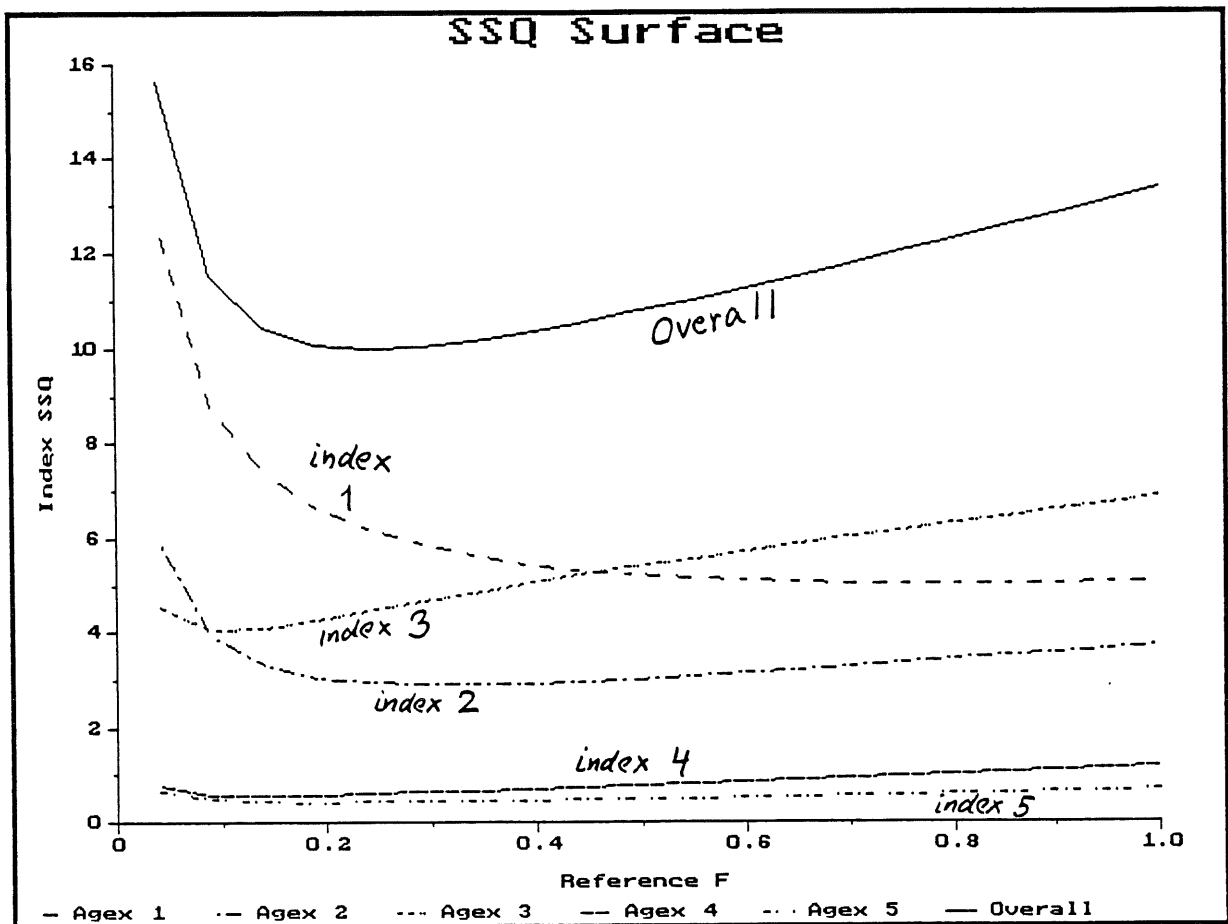


Figure 3 8.1 *Western Baltic Herring. Output from ICA.*

Index sum of squares of deviations between model and observations (survey index) as a function of the reference F in 1994

INDEX 1: 1980-95: IYFS IIIa, Age groups 2 and 3+.

INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age groups 0-3+.

INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age groups 0-3+.

INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 2-8.

INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age groups 0-8

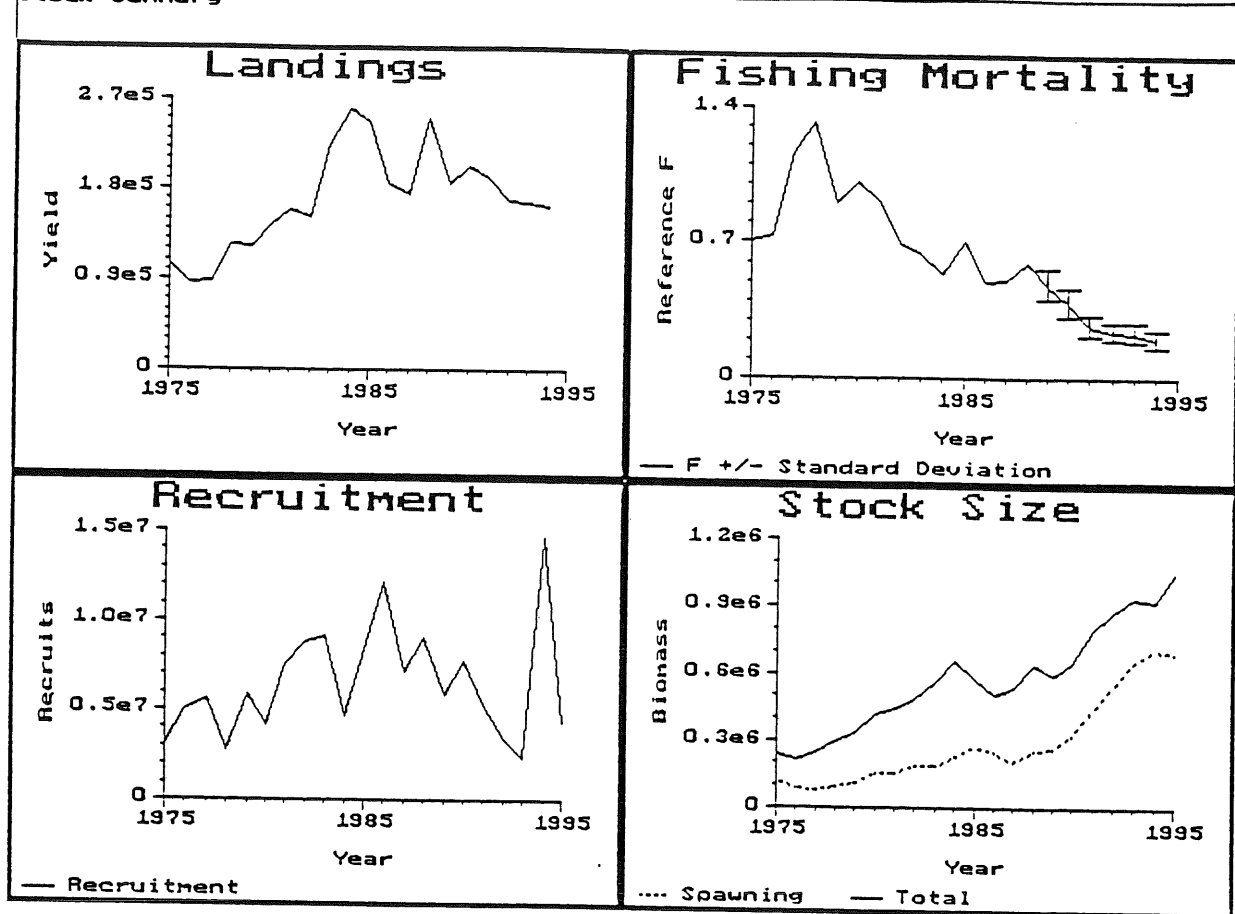


Figure 3.8.2 Western Baltic Herring. Output from ICA. Stock summary

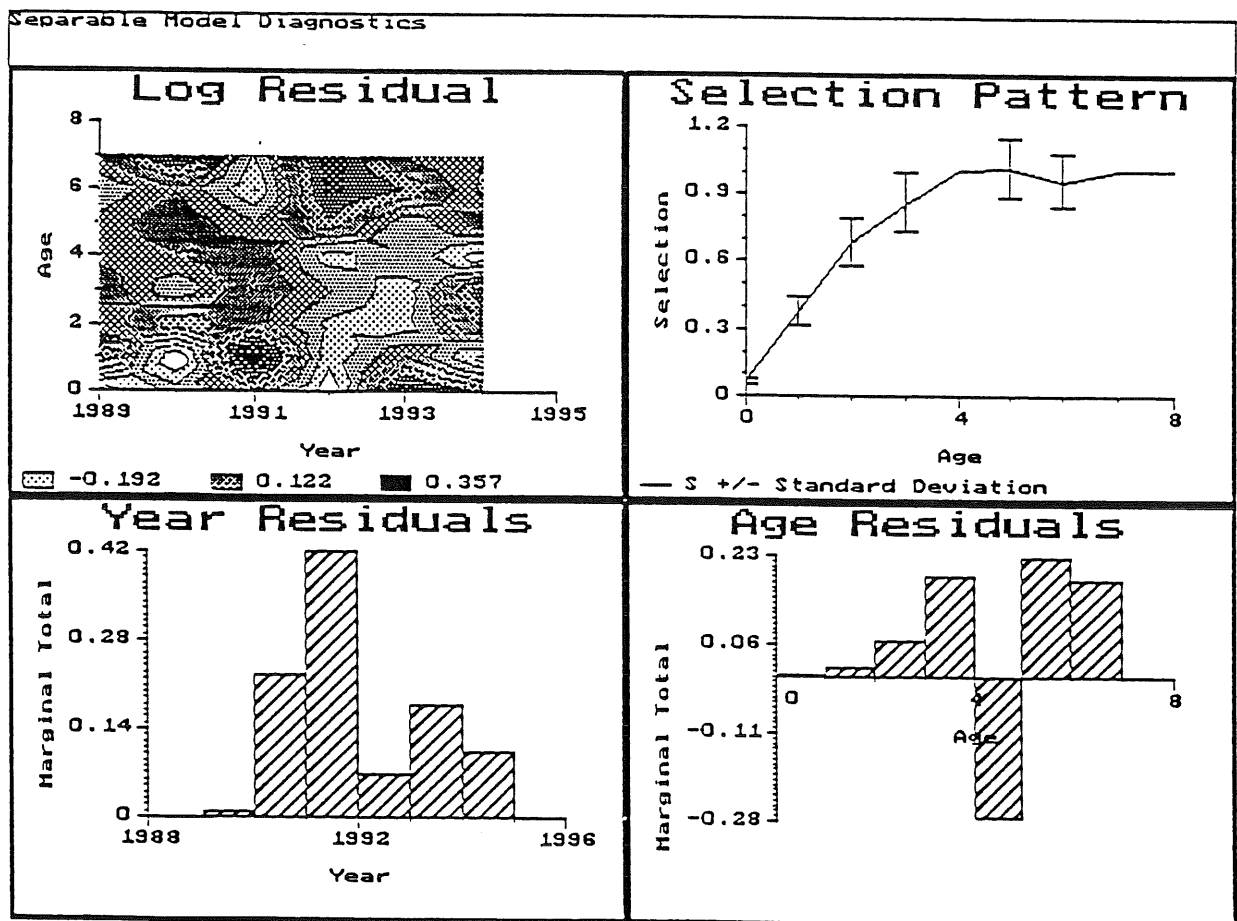


Figure 3.8.3 Western Baltic Herring. Separable model diagnostics.

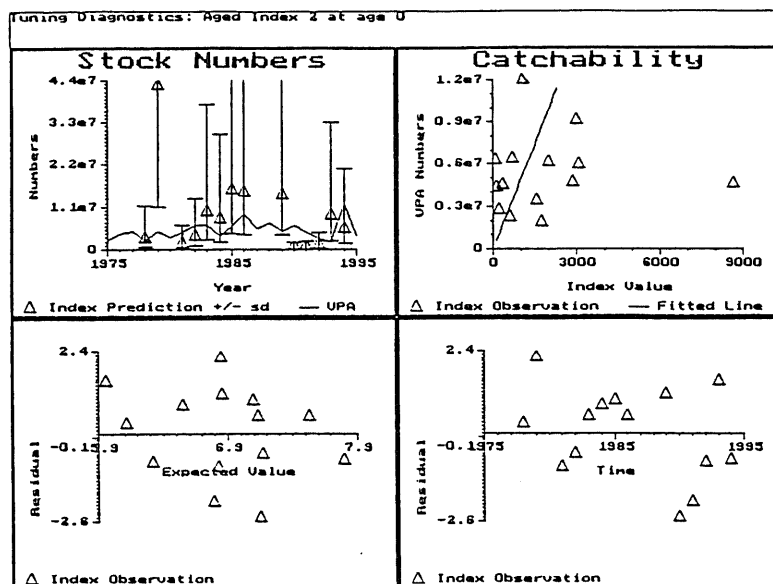


Figure 3.8.5a *Western Baltic Herring. Tuning diagnostics.*
INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age group 0.

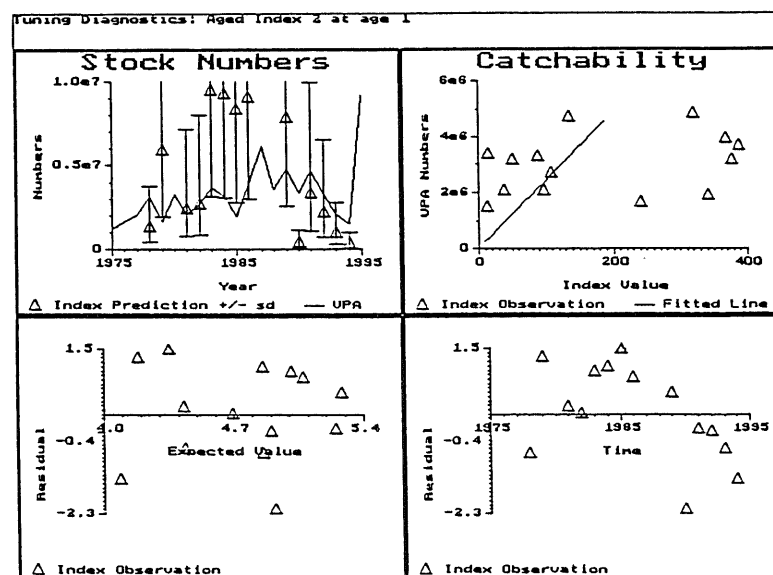


Figure 3.8.5b *Western Baltic Herring. Tuning diagnostics.*
INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age groups 1.

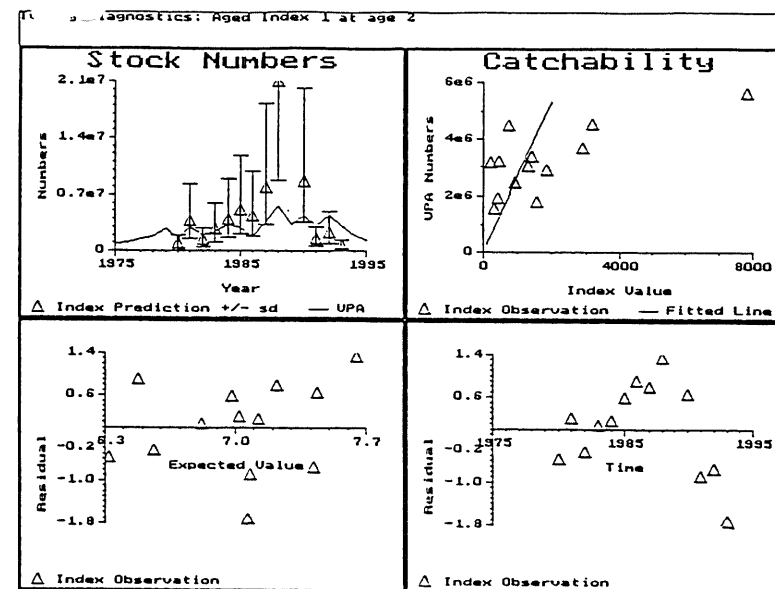


Figure 3.8.4a *Western Baltic Herring. Tuning diagnostics.*
INDEX 1: 1980-95: IYFS IIIa, Age group 2.

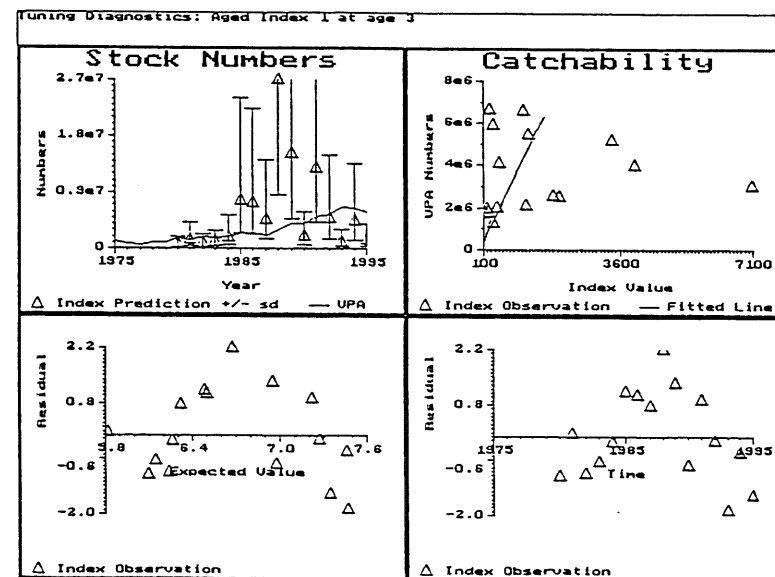


Figure 3.8.4b *Western Baltic Herring. Tuning diagnostics.*
INDEX 1: 1980-95: IYFS IIIa, Age group 3+.

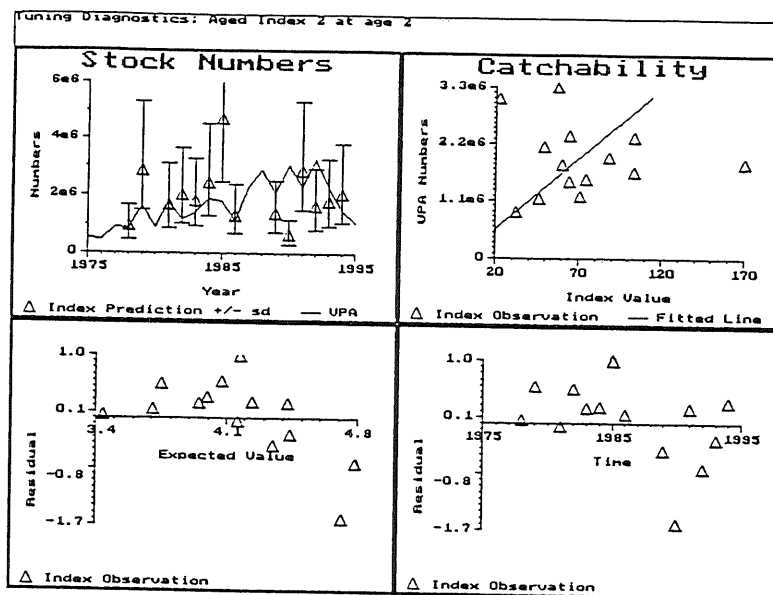


Figure 3.8.5c Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age groups 2.

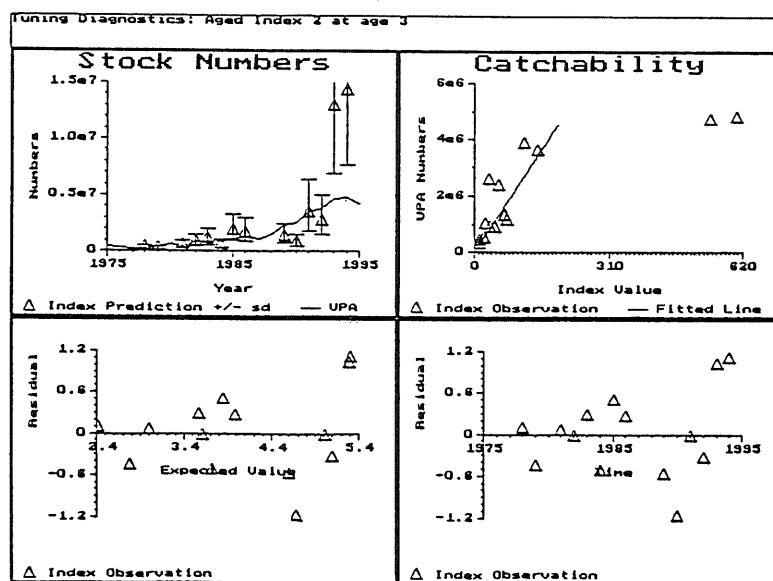


Figure 3.8.5d Western Baltic Herring. Tuning diagnostics.
INDEX 2: 1978-94: German Bottom Trawl Survey in Sub.Div. 24, Age groups 3+

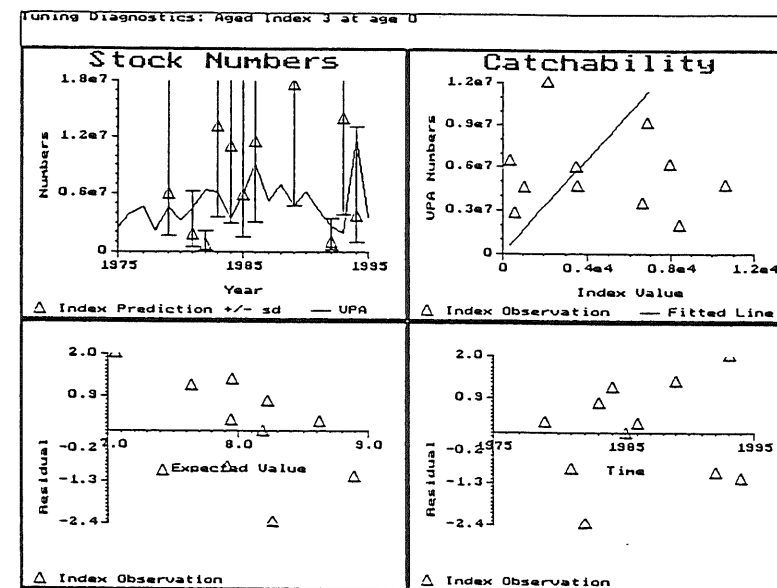


Figure 3.8.6a Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age group 0.

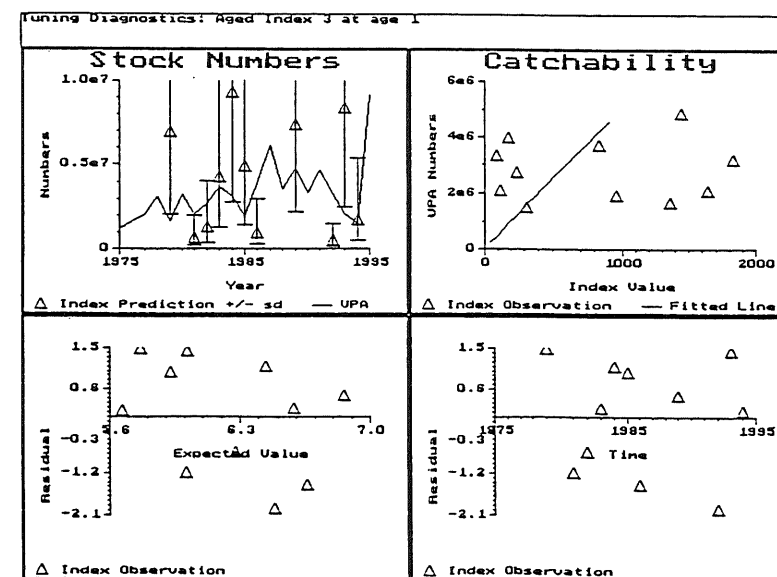


Figure 3.8.6b Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age group 1.

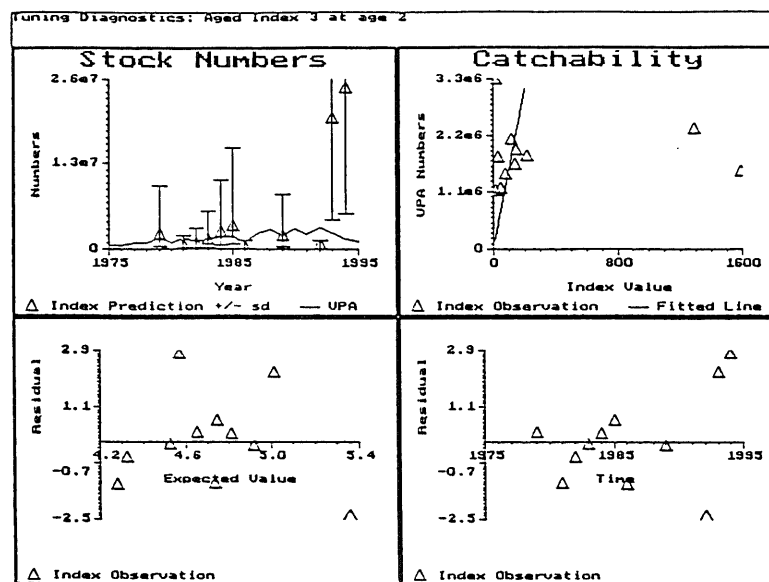


Figure 3.8.6c Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age group 2.

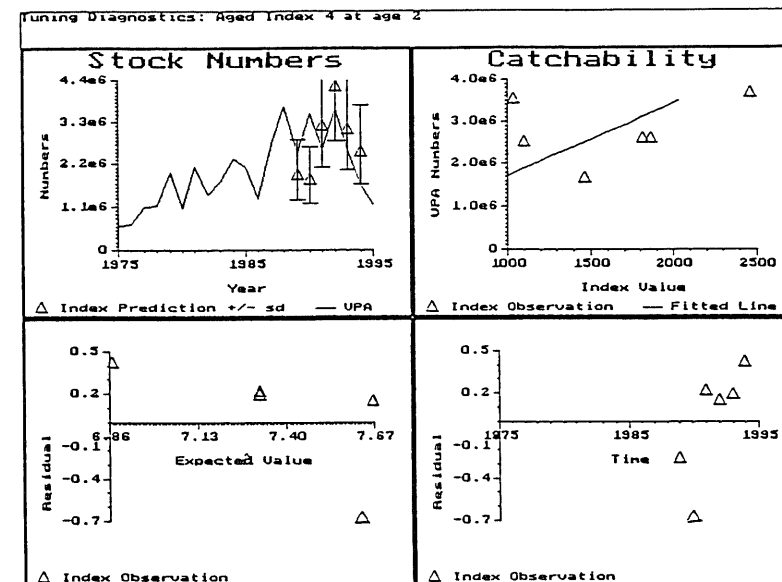


Figure 3.8.7a Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age group 2.

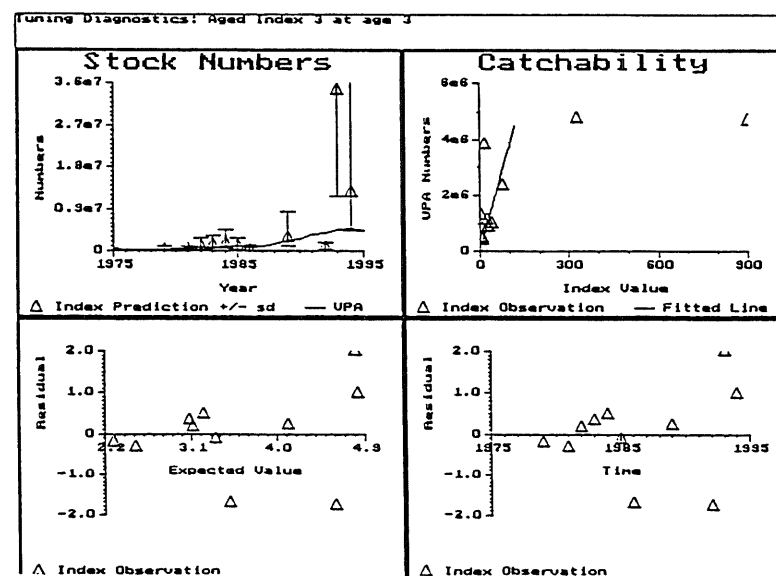


Figure 3.8.6d Western Baltic Herring. Tuning diagnostics.
INDEX 3: 1979-94: German Bottom Trawl Survey in Sub.Div. 22, Age group 3+.

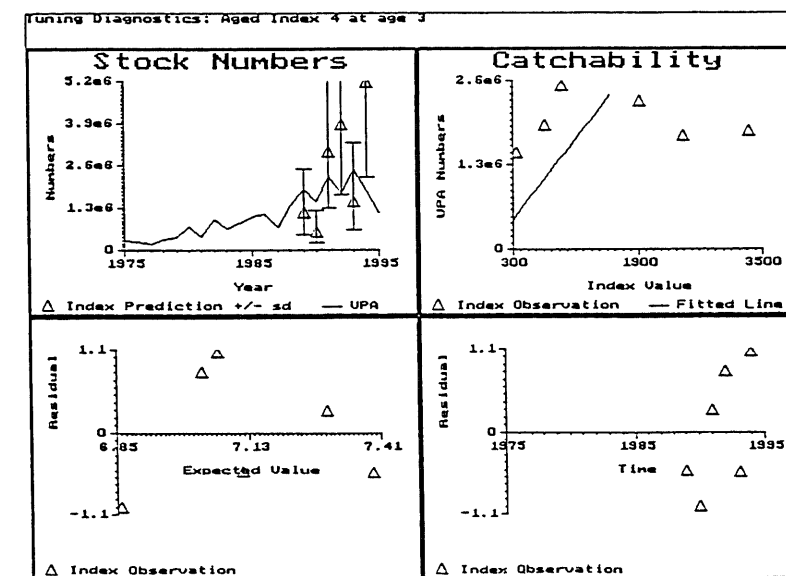


Figure 3.8.7b Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age group 3.

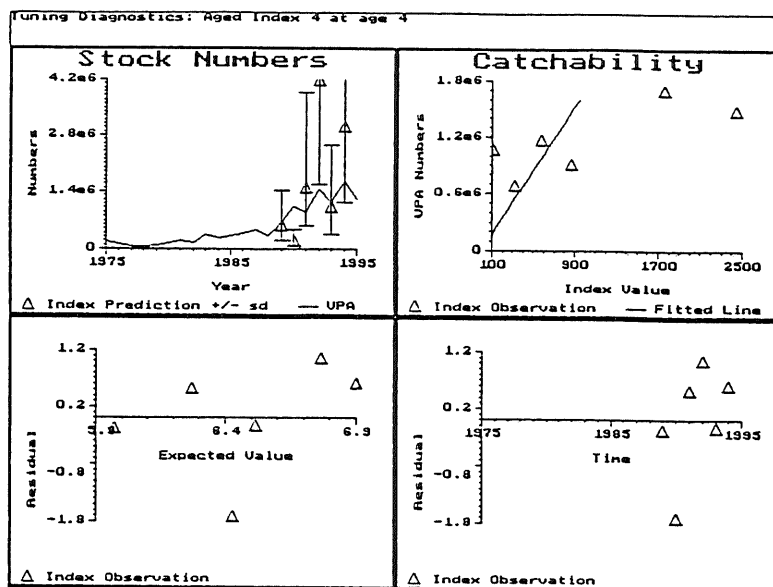


Figure 3.8.7c Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 4.

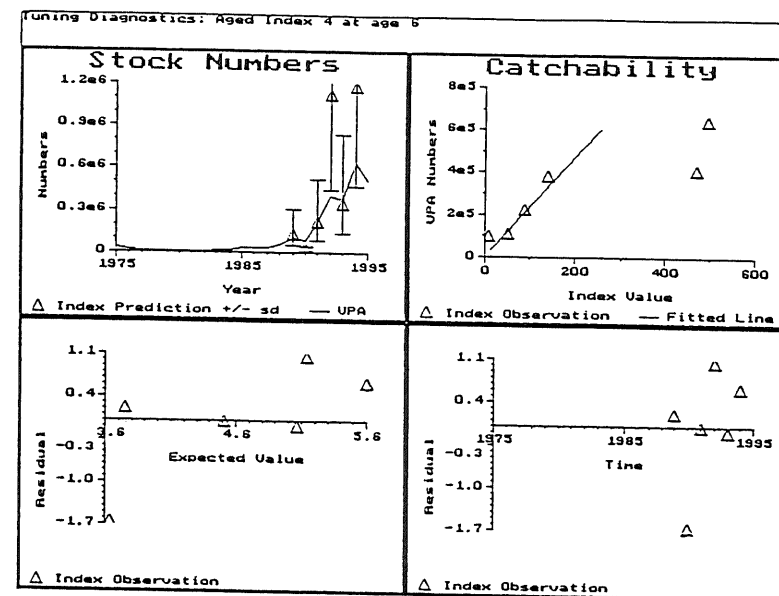


Figure 3.8.7e Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 6.

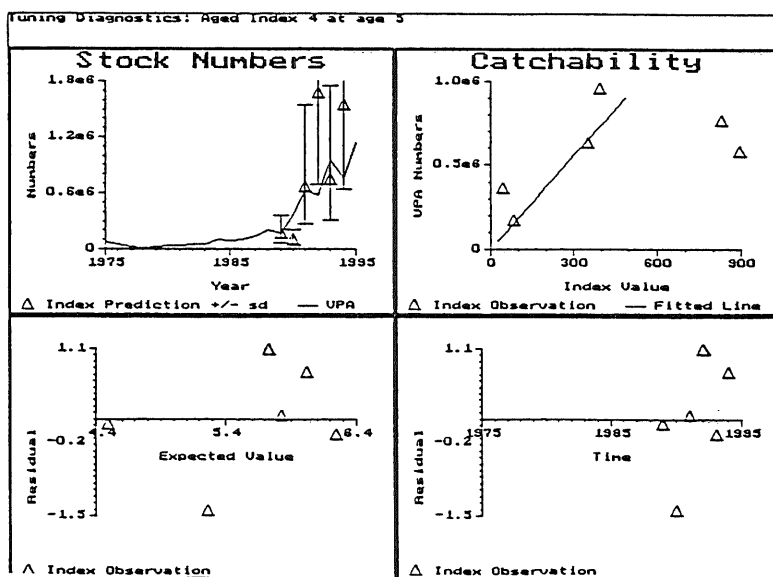


Figure 3.8.7d Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 5.

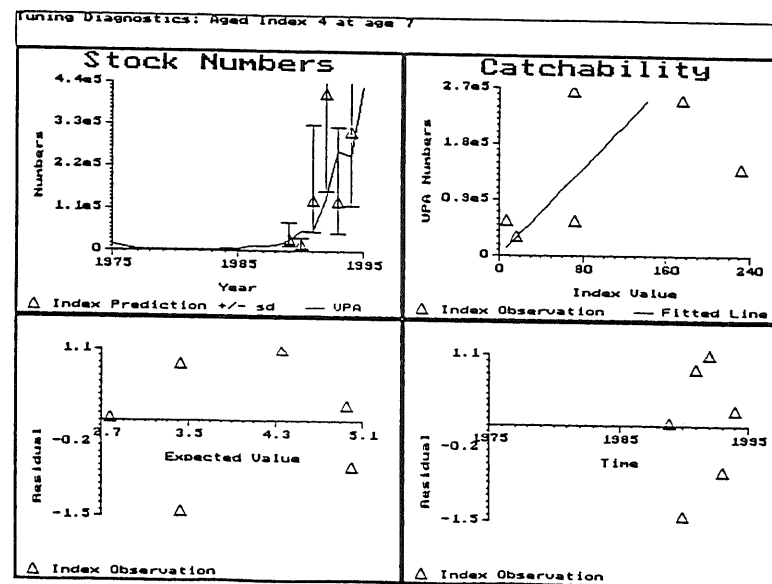


Figure 3.8.7f Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 7.

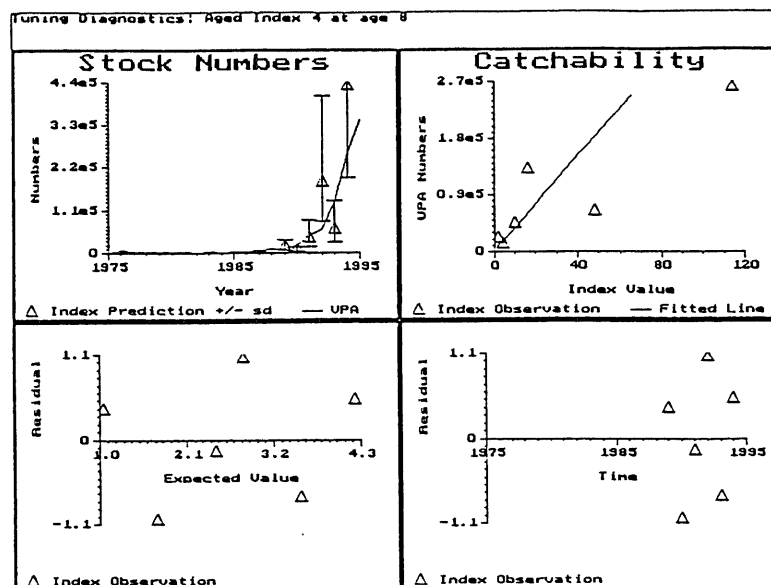


Figure 3.8.7g Western Baltic Herring. Tuning diagnostics
INDEX 4: 1989-94: Acoustic survey in IIIa+IVaE, Age groups 8.

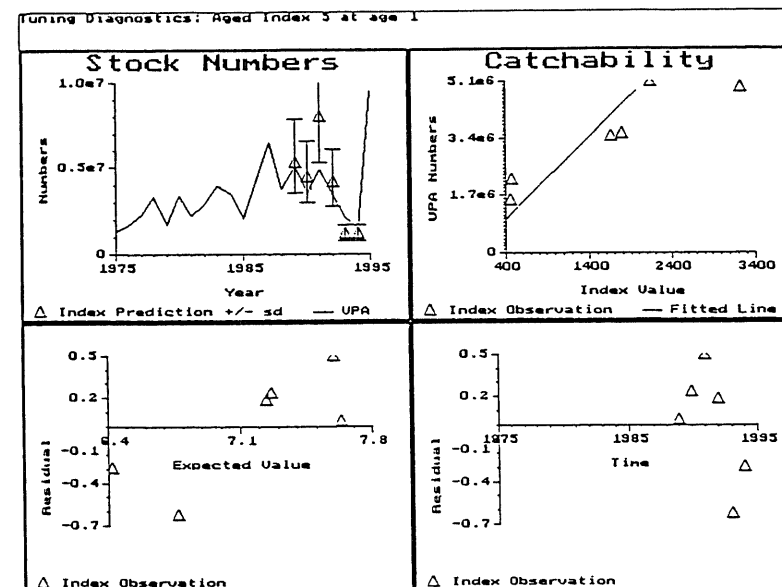


Figure 3.8.8b Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 1.

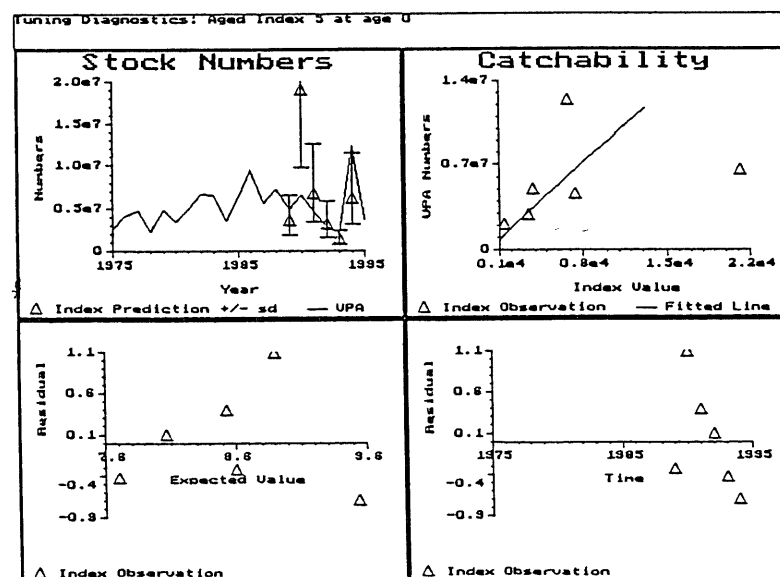


Figure 3.8.8a Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 0

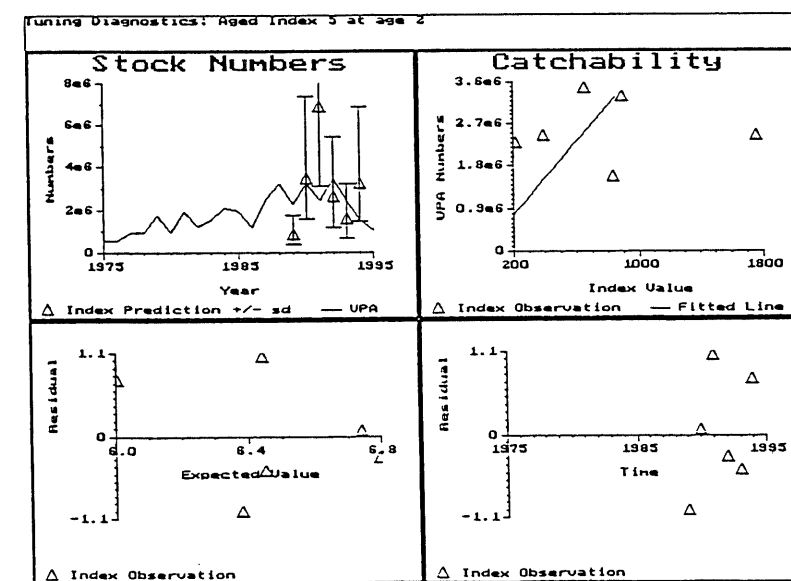


Figure 3.8.8c Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 2.

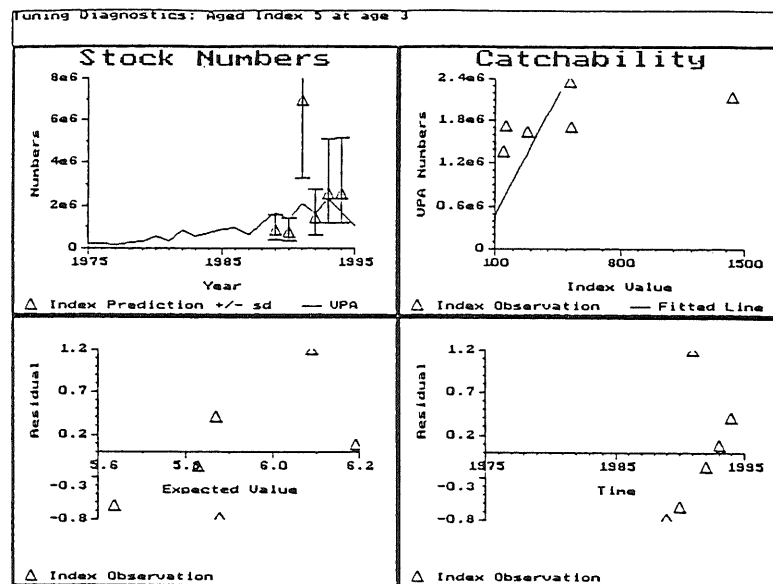


Figure 3.8.8d Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 3.

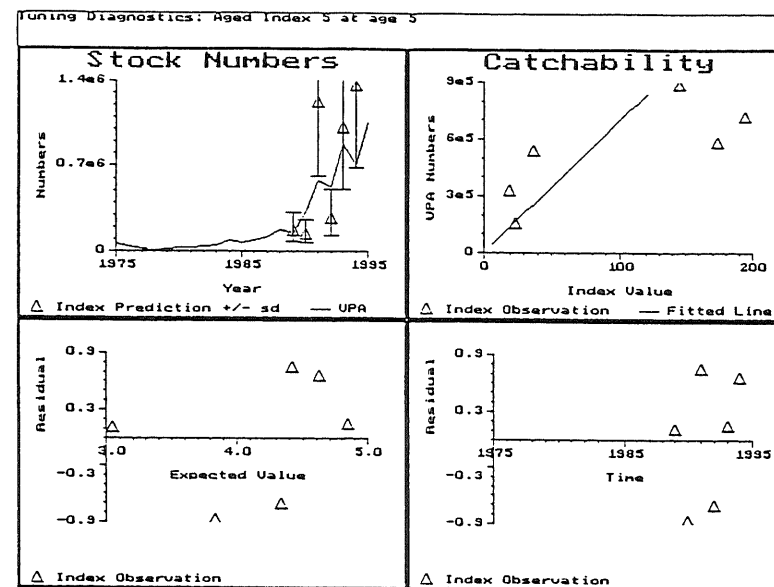


Figure 3.8.8f Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 5

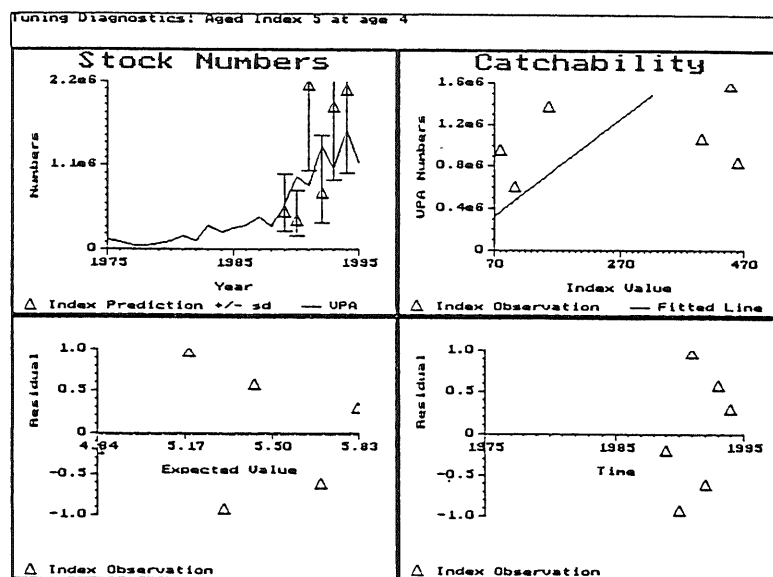


Figure 3.8.8e Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 4

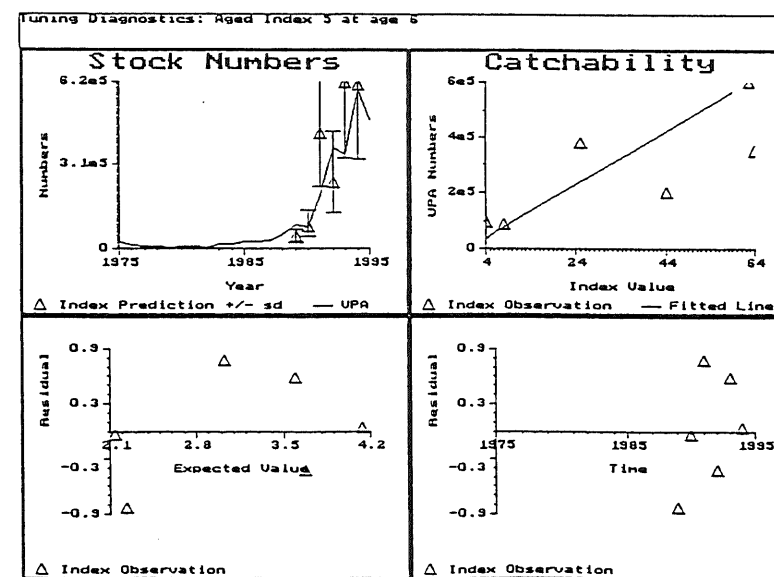


Figure 3.8.8g Western Baltic Herring. Tuning diagnostics
INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 6

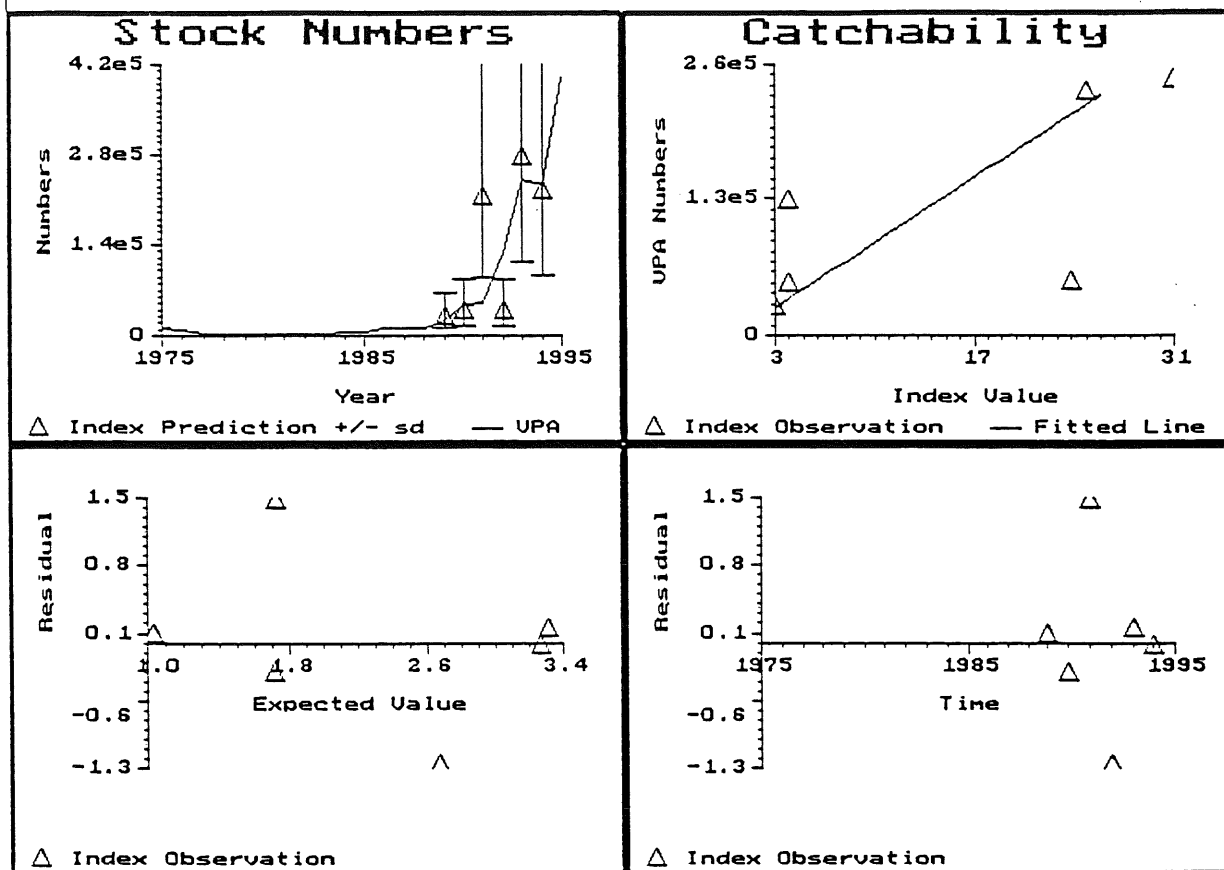


Figure 3.8.8h

Western Baltic Herring. Tuning diagnostics
 INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 7

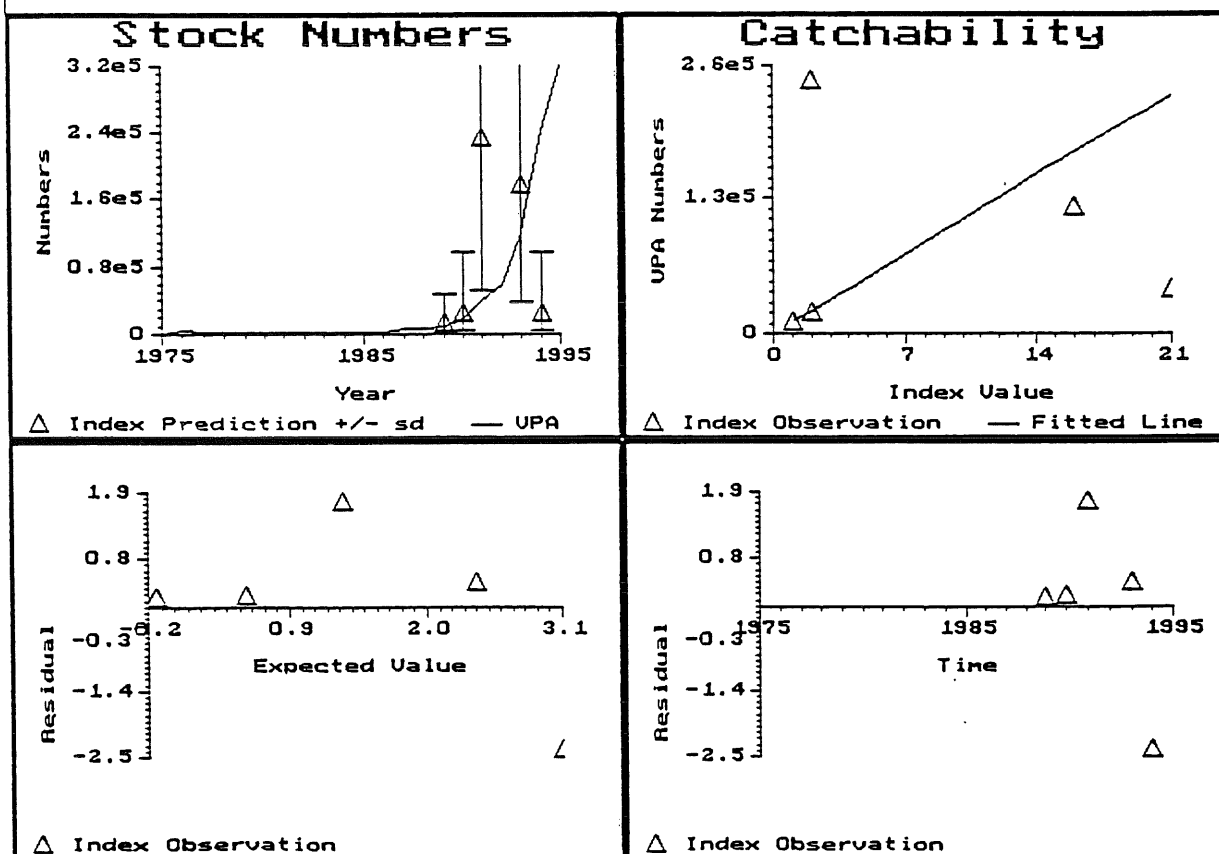
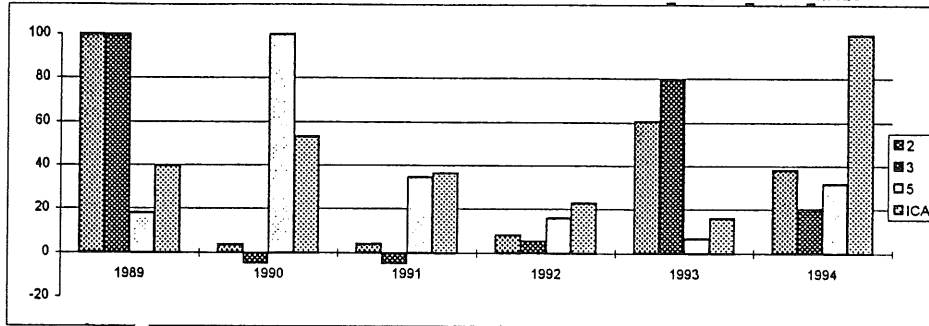


Figure 3.8.8.i.

Western Baltic Herring. Tuning diagnostics
 INDEX 5: 1989-94: Acoustic survey in Sub.Div 22-24, Age group 8

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**Figure 3.8.9a** Age group 0 by index and ICA-stock estimate.

Western Baltic Herring

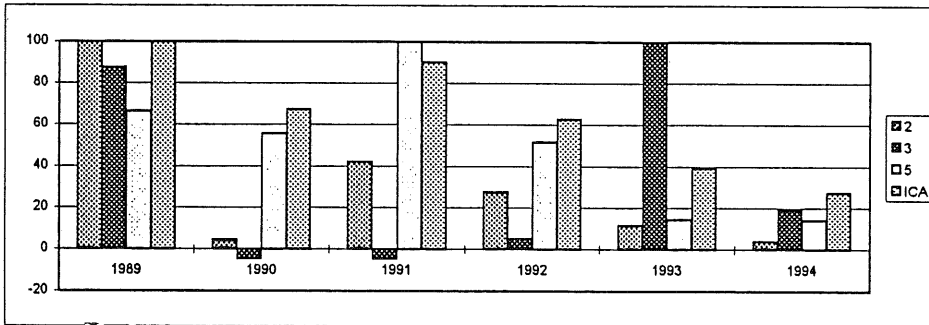
Indices (and ICA-estimates) are relative : $100 \times \text{Index} / \text{Maximum} \{ \text{Index}_{89}, \dots, \text{Index}_{94} \}$

INDEX 1 IFYS IIIa Ag groups 2 nd 3+ INDEX 2 German bottom trawl survey in sub-div. 24

INDEX 3 German bottom trawl survey in sub-di INDEX 4 Acoustic survey in division IIIa+IVa

INDEX 5 Acoustic survey in sub-division 22+24

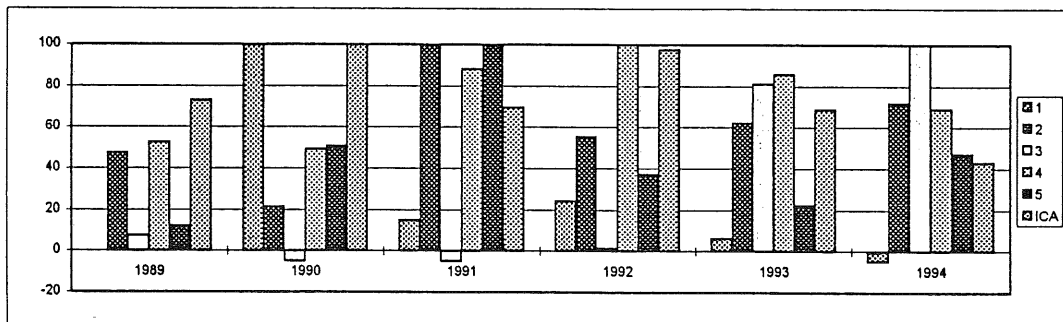
Negative value: No data

**Figure 3.8.9b** Age group 1 by index and ICA-stock estimate.

Western Baltic Herring

Indices (and ICA-estimates) are relative : $100 \times \text{Index} / \text{Maximum} \{ \text{Index}_{89}, \dots, \text{Index}_{94} \}$

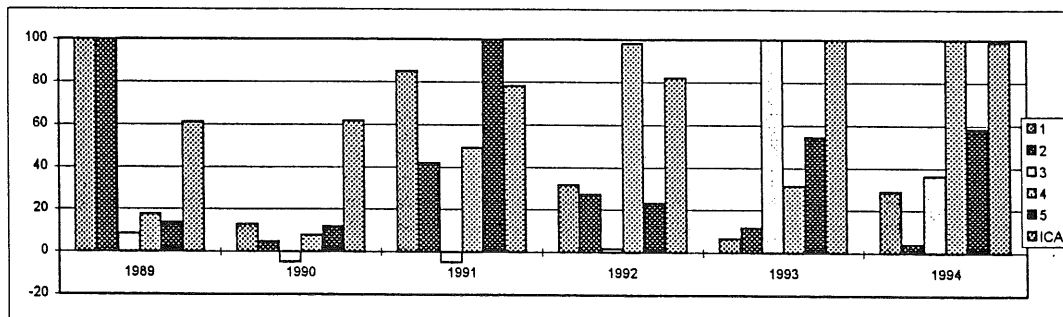
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**Figure 3.8.9c** Age group 2 by index and ICA-stock estimate.

Western Baltic Herring

Indices (and ICA-estimates) are relative : $100 \times \text{Index} / \text{Maximum} \{ \text{Index}_{89}, \dots, \text{Index}_{94} \}$

Negative value: No data

**Figure 3.8.9d** Age group 3+ by index and ICA-stock estimate.

Western Baltic Herring

Indices (and ICA-estimates) are relative : $100 \times \text{Index} / \text{Maximum} \{ \text{Index}_{89}, \dots, \text{Index}_{94} \}$

Negative value: No data

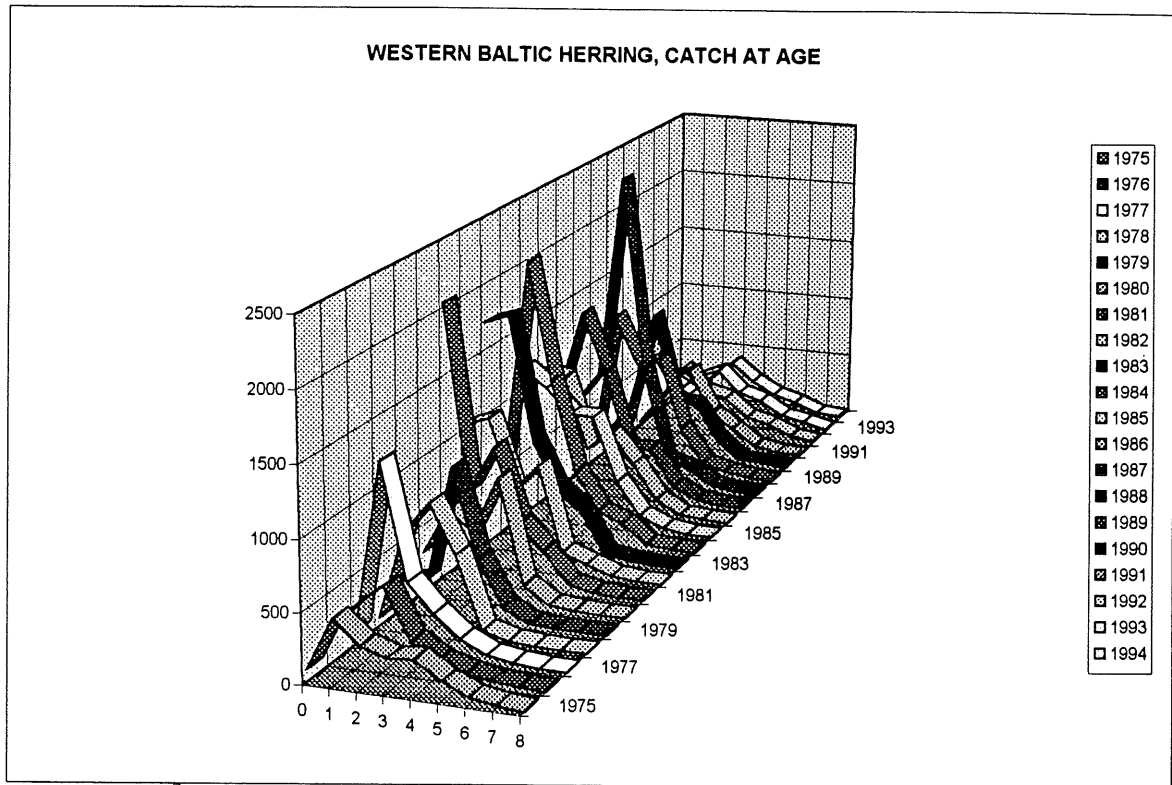


Figure 3.8.10 Catch at age of Western Baltic Herring.

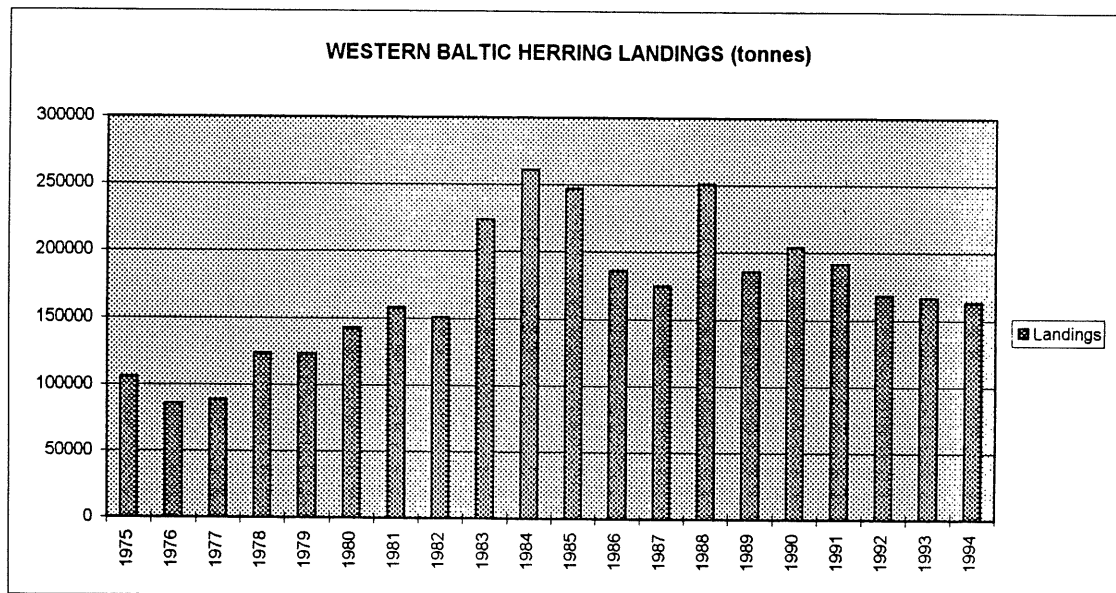


Figure 3.8.11 Landings of Western Baltic Herring.